BRAIN:

A JOURNAL OF NEUROLOGY

EDITED

FOR THE NEUROLOGICAL SOCIETY OF LONDON

BY

A. DE WATTEVILLE

VOL. XVI.

London:
MACMILLAN AND CO.
AND NEW YORK.
1893.

Reprinted with the permission of MACMILLAN AND CO. LTD.

JOHNSON REPRINT CORPORATION JOHNSON REPRINT COMPANY LTD.
111 Fifth Avenue, New York, N.Y. 10003 Berkeley Square House, London, W1X6BA

Original Articles.

ON DISTURBANCES OF SENSATION WITH ESPECIAL REFERENCE TO THE PAIN OF VISCERAL DISEASE.[1]

BY HENRY HEAD, M.A., M.D.
University College Hospital.

INTRODUCTORY.

SEVERAL years ago I was led to examine the positions occupied by pain in disorders of the stomach and I soon came to the conclusion that the usual description was incomplete in several respects. For firstly the positions over which the patient experienced pain in gastric disturbances were more numerous than was usually supposed, and secondly the pain was in many cases associated with definite cutaneous tenderness. Moreover the cutaneous tenderness was in many cases not confined to small spots or areas, but occupied whole tracts of skin with definite borders. I was thus led to investigate the pain and accompanying tenderness consequent on disturbances of other organs, and I found that these sensory disturbances also followed definite lines.

After Ross's most suggestive papers it seemed exceedingly probable that these areas bore some definite relation to nerve distribution, and I then began to investigate the distribution of herpes zoster in the hope that a skin lesion which was notoriously of nervous origin might throw some light on the meaning and significance of the tender areas in visceral

[1] Read as a Thesis before the University of Cambridge, June, 1892, and before the Neurological Society of London, November 10th, 1892.

disease. To my surprise I found that the areas occupied by herpes zoster exactly corresponded to those with which I was familiar in visceral disease.

I next attempted to determine to what level of the nervous system these areas belonged, with the help of cases in which gross organic lesions were present. By this means it became apparent that each of these areas represented the distribution of either a single nerve root or of a single segment in the spinal cord.

Thus I was enabled to map out the areas supplied by the various segments of the cord on the surface of the body. It then became apparent that certain of these areas were never affected in visceral disease, and this led me to examine the sensory supply of the viscera from the sympathetic system. Now Ross had already suggested that in visceral disturbances pain (and therefore in my cases tenderness) was referred along the distribution of the somatic nerves which came off from the same part of the cord as the sensory sympathetic fibres to the organ affected. Thus if I could map out the somatic areas along which pain was referred in visceral disease I could say, on Ross's hypothesis, what was the sensory supply from the sympathetic of the particular organ affected. By this means I obtained another scheme showing the distribution of the sensory sympathetic fibres analagous to that which Gaskell constructed for the motor and inhibitory fibres of the same system.

The next question that arose was whether these tender areas appeared only in visceral disease, and I soon found that they appeared to a greater or less extent in many general diseases, such as anæmia, ague and fever of all kinds.

An examination of the zones of analgesia or of tenderness in so-called hysteria showed that the sensory disturbances in this disease fall into two great groups—in one of which the areas of sensory disturbance followed the spinal type, whilst in the other the distribution was fundamentally different.

This opened up the whole question of sensation in its various forms, but in this paper I shall not do more than

touch upon the relations between the distribution of the sensation of pain, of heat, of cold and of touch.

In the present paper I shall confine myself to the discussion of the disturbances of sensation, &c., below the level of the clavicles, for although every general statement applies equally to the head and neck and the body below the clavicles, the problems opened up by a consideration of the areas of tenderness occurring in the head and neck are so wide reaching that I must reserve them for a subsequent paper in the near future.

CHAPTER I.

General.

§ 1. Characteristics of the areas.

§ 2. The relation between the pain areas and the distribution of Herpes Zoster.

§ 3. Topographical.

§ 1. *The pain and areas of tenderness in visceral disease; their characteristics, and the means for their demonstration.*

In order to appreciate the characteristics of the areas of tenderness which appear in visceral disease it is best to take an example. In the type of case which is so common in our hospitals where a patient suffers from pain after food with or without hæmatemesis, an area of cutaneous tenderness is sometimes found which can be marked out as follows. The skin and subcutaneous tissues are taken up gently between the finger and thumb at various points on the abdomen. As soon as we pass a line extending from a point about two and a-half inches above the umbilicus to the tip of the eighth rib the patient at once complains of pain. On working from below upwards, tenderness is complained of as soon as a line is passed extending from the umbilicus to the tip of the tenth rib. The tenderness may lie entirely to the left of the middle line of the abdomen or there may be an exactly similar area on the right side.

If unilateral the tenderness is in the form of a triangle with the base at the linea alba, one side formed by a line with an upward slope from the umbilicus to the ribs, and

the third side extending from the eighth rib to a point on the middle line of the abdomen two and a-half inches above the umbilicus. The apex is situated at about the ninth space. Now this anterior portion is associated with a posterior portion, also roughly a triangle. Its base is formed by the eleventh and twelfth dorsal spines, and its apex reaches a little further forward than the line of the posterior axillary fold.

A still better method of marking out such an area is to take a pin with a round head of such a size that it is obviously blunt to all parts of one's own cheeks and face. Travel over the surface of the abdomen using the blunt end only, in the same way as if you were using the point to test for analgesia. In a favourable case the patient does not complain until the limits of the tender areas are reached, when he at once complains that he is intensely sore and he will even cry out that you are pricking him. Thus in a favourable case the increased sensibility is so great that the contact of the blunt head of a pin is mistaken for a prick of the point. Subsequently in this paper this phenomenon will appear in my notes of cases as "head of pin called point." In a large number of cases there is no such confusion, but the patient says that, although he knows that the blunt end is being used, it gives him great pain. He feels "sore and bruised, as if he had been beaten about the body or back."

It is wonderful how unanimous patients are in their description of the sensation produced by touching such a tender area. I for one can fully confirm the description usually given by patients of their sensation; for such tender areas when touched, give exactly the sensation produced by touching a bad bruise. Many of my readers will have at one time or another suffered from these tender areas, and will be able to bear out my description.

I must warn my readers from supposing that the patient cannot tell the difference between the head and the point of a pin on these areas. Far otherwise. The touch of the head of a pin feels to him like a prick on a normal skin surface, whilst the point gives him acute pain far in excess of that caused by a prick upon the normal skin.

Another method for bringing out these tender areas, which is clumsy but theoretically interesting, is the use of a warm sponge or of a test tube filled with moderately warm water. As soon as the tender area is reached the patient experiences a feeling of great heat and flinches under the application. The same effect can be produced by moderate cold except that even moderate cold is at all times unpleasant to the skin of the abdomen, whilst moderate warmth is pleasant, and thus brings out the contrast between the normal and the altered sensory areas in a much clearer manner.

Another characteristic of these tender areas is the increased reflexes which can be obtained from them. This is a subject to which I shall return later, but I may mention here that whenever a portion of the skin becomes hyperalgesic from visceral disturbances the reflexes normally obtainable from that area are much increased. This is beautifully seen when the hyperalgesia affects the skin of the abdomen or buttock on one side only, so that the reflexes on the two sides can be compared with one another.

Immediately below the area of the abdomen which I have just described lies a tender zone which frequently appears in visceral disease. This area is bounded above by a line running from the umbilicus to the tip of the tenth rib and thence directly backwards to the first lumbar spine. Now supposing this sub-umbilical area is tender, no matter how intense the tenderness may be, its upper border never extends beyond this upper limit. Should the area which I have described above the umbilicus be marked out by tenderness its lower border never extends below the same line, however tender it may be. Again should the sensation of pain be entirely absent over either of these areas, in consequence of a destructive lesion to the spinal nerve roots or cord, we never find that the upper and lower limits of these two areas encroach upon one another *provided a prick is the test used for anæsthesia.* Thus it is evident that these areas do not overlap one another, and it is a peculiar characteristic of these areas of painful sensation that wherever they are situated on the surface of the body, whether they be marked

out by hyperalgesia or analgesia, their limits never materially alter or overlap. Thus if we take any three areas adjacent to one another, of which the uppermost and the lowest are tender, the clear space between them of unaffected skin will represent the full extent of the middle area. This is both curious and unexpected, for we know that the areas on the skin supplied by the nerve roots [1] overlap considerably, and as a necessary result a circumscribed lesion does not produce a sharp border of anæsthesia to touch.

I have so far spoken as if a visceral lesion always caused tenderness over the whole of its appropriate area. This is not by any means the case. In disturbances of the stomach, instead of a whole tender area such as I have described above, we frequently find two tender spots from an inch to an inch-and-a-half in diameter situated over the costal margin at about the tip of the ninth rib, together with a posterior spot generally situated near the eleventh and twelfth dorsal vertebræ, a little to one side of the middle line. Now, if the patient is asked where his pain is situated, he will point to one or both of these spots. Again, it is possible that he may suffer from pain only, without any tender spots on the skin, much less a whole band of tenderness reaching to the middle line in front. But even if cutaneous tenderness is absent, the pain is referred to the position of the maximum tenderness corresponding to the affected areas. Thus in cases of stone in the kidney, the maximum pain is situated at the tip of the twelfth rib, and at this point we can frequently demonstrate considerable cutaneous tenderness ; this point obviously lies in the subumbilical area which I have described above. Every such area of cutaneous tenderness has one or more maximum points, the position of which is exceedingly important, for it is to the situation of these maxima that the patient refers his pain. Thus in each case, given the position to which the patient refers his pain, I can say to what area the pain belongs. For I recognise in these points to which the pain is referred the maxima of an area whose limits I have occasionally found marked out

[1] Sherrington, *Proc. Roy. Soc.*, vol. 52.

completely by tenderness. So fixed are these maxima, that supposing a whole area is tender, we can confidently predict that as the disturbance subsides, the tenderness will become limited to certain points, and when the disturbance has subsided still more, pain only will be left referred to the same points as the maxima. When I come to speak of the limits and relations of these areas, I shall therefore lay stress on the position of the maxima in each area as I describe it, for these maxima give us the clue to the meaning of pain referred to various spots on the body.

§ 2. *The relation between the tender areas in visceral disease and the areas affected in herpes zoster.*

Before I proceed to describe the limits of the tender areas in visceral disease, I must digress for a moment to point out how I have been helped in this investigation by certain trophic skin lesions, especially herpes zoster.

A controversy has long raged as to the true significance of herpes zoster, for it is at once evident to anyone who closely examines a case of herpes that the distribution of the vesicles does not in many cases follow the distribution of any peripheral nerve. As each case appears in the out-patient room, an attempt is made to show that it follows the course of an intercostal nerve, but such attempts mostly break down, and it is assumed that more than one nerve is affected. In Germany it has long been recognised that the eruption does not follow the line of any one nerve, and an attempt has therefore been recently made to explain its distribution by supposing it depends on the vascular system. This attempt, however, has not been satisfactory.

Now it has always been taught that herpes zoster is probably an inflammation of the posterior roots,[1] and that this explains the want of harmony between its distribution and that of the peripheral nerves. It therefore struck me that, if this were so, a careful collection of the areas occupied by herpetic eruptions would be an excellent

[1] Von *Bärensprung Annalen d. Charité*, Bd. ix. 2, Bd. x. 1, Bd. xi. 2.

method of mapping out the long sought distribution of the posterior roots. I therefore proceeded to collect cases of herpetic eruptions, and was astonished to find that they agreed in an extraordinary way with the areas of tenderness I had observed in visceral disease, for not only did the actual areas occupied by the eruption agree with the areas of tenderness, but I found that if the herpetic areas were carefully marked and measured, they were never found to overlap. Moreover the advent of the eruptions is mostly preceded by pain and tenderness of the skin. In three cases in which I was fortunate enough to see the patient before the eruption was developed, I was able to mark out an area on the skin which exactly corresponded to that seen in visceral disease, and I was unable at the time to say whether this area was due to reference from visceral disturbances, or was the percursor of a herpetic eruption. Again the herpetic eruption always makes its first appearance at certain points, from which in most cases it spreads. But even if the eruption spreads until it occupies the whole area, these points of first appearance are always the most affected. Now these points correspond to the positions of pain and maximum tenderness in visceral disease. Thus the areas occupied by herpetic eruption correspond to those which become tender in visceral disturbances in three points.

1st. They have the same distribution.

2nd. They do not overlap.

3rd. They have the same maxima.

Thus in the herpetic eruption I had a means of actually seeing the areas I was investigating, marked out for me on the surface of the skin.[1]

[1] I feel inclined to think that herpes zoster may be etiologically divided into two groups.

1st. The eruption may be secondary to irritation of the spinal cord, &c., by Caries or other nervous diseases, such as tabes dorsalis, or may be due to some nerve irritant such as arsenic.

2nd. The type of herpes which represents an acute specific. The onset of the illness is preceeded by 5 to 7 days fever thirst, loss of appetite, &c. The illness may begin with a rigor, or in a child with vomiting. The temperature falls with the outbreak of the eruption. The position of the eruption may, in some cases, be determined by long continued irritation, such as chronic cough, chronic intestinal catarrh, &c., but in many cases no such predisposing cause can be traced.

The herpetic eruptions which I shall use to illustrate this paper, are selected from a collection of sixty-two cases, all of which lay below the eighth cervical segment. Each case was drawn by myself from at least three points of view, and from a quarter to half-life size.

I cannot now enter into the question as to how far other skin diseases throw light on the distribution of these areas. I have interpolated the above short explanation in order that I may refer to the distribution of herpetic eruptions when we are discussing in the next section the limits of the areas of tenderness in visceral disease.

§ 3. *Topography.*

In the previous sections, I fear I may have led my reader to suppose that it would be an easy task to map out the areas of tenderness in visceral disease for the whole body. This is, however, not the case in practice. The first difficulty that meets us, is the only partial appearance of the areas in the forms of maximum tender spots. Now for these maximum spots to be of value, it is necessary that the whole area to which they belong should have frequently come under the notice of the observer, and yet it is only in a small proportion of the cases that he has the chance of seeing the area in its full development.

Then again, it is rare for one area only to be tender. In most cases, several areas are present at once; however, we frequently find that of three areas adjacent to one another, 1 and 2 will be present on one occasion, 2 and 3 on the next, and thus the limits of the three areas can be judged by exclusion. In fact, those cases where one area only is tender occurs so seldom, that if we had to depend upon such cases, many hundreds would be necessary before one could be found to satisfy our requirements.

But this leads me to speak of another difficulty which is by far the most formidable if we depend only on the areas which are produced by visceral disease. There are certain areas on the body which are extremely rarely affected. If they should be tender, they mostly appear in combination,

first lumbar area and ends just above the knee, and on the inner side by adjoining the ascending limit of the third lumbar.

Thus we have now filled up the gap in the leg which is unaffected in visceral disease, and seen that it probably represents the supply of pain fibres from three segments, the second, third and fourth lumbar.

It would take me too long to discuss here how the gap on the arm is to be filled up, and I must reserve the full discussion for a future paper on the areas of the head and neck.

Now the descending branches of the cervical plexus which came off as low as the fourth cervical root supply the skin over the first two ribs and over the point of the shoulder. This represents the lowest limit of the areas of referred tenderness in the head and neck.

Thus the gap in the arm which is unaffected by visceral disease probably represents the distribution of the pain fibres of the fifth, sixth, seventh and eighth cervical segments.

Conclusions.

We have now been able, with the help of traumatic lesions of the spinal cord, to name each area according to the spinal segment to which it belongs. Thus the dorso-ulnar area represents the supply of the first dorsal segment, and the gluteo-crural that of the first lumbar, and each of the eleven intervening areas represents the supply of one segment whose number we now know.

In a similar manner we found that the gluteo-pudendal area represented the supply of the third sacral segment—the fibulo-dorsal that of the fifth lumbar, and the intervening areas have been numbered according to the segments to which they belong

We have also seen that the "gap" corresponds to the second, third and fourth lumbar segments, and we have been able from the lesions produced by organic disease to approximately apportion the skin into areas corresponding to each of these segments.

CHAPTER III.

Pain and Tenderness in Disturbances of Special Organs.

Introductory.

We have now seen that the whole of the body and limbs can be marked out into areas, each of which I have attempted to show, corresponds to the cutaneous distribution of the pain fibres given off from one segment of the cord. I shall now try and put before you the extent to which these areas are affected in diseases of the various organs.

It is a well-known fact that the pain of visceral disease is not always localised by the patient over the organ affected. Ross first explained this fact by the ingenious hypothesis that the pain of visceral disease was referred along the distribution of the somatic roots which came off from the same level of the cord as the sympathetic fibres to the organs affected. He collected a large number of cases of pain, and his intimate knowledge of the sensory distribution of certain roots enabled him to say definitely that in certain cases, the distribution of the pain corresponded exactly with that of certain roots.

The description given by patients of their pain is, however, so unsatisfactory, that this important work did not bear fruit to the extent that might have been expected.

An enormous advance was made when Dr. Mackenzie[1] described the cutaneous tenderness which is so frequently associated with the pain of visceral disease. For here we have a symptom which is distinctly more objective than that of pain only. He proceeded to collect a large number of cases in which the tenderness was present over one or more points, and in the course of this section, I shall repeatedly refer to his interesting paper. Although we worked independently and published at the same time, our results agree to an extent that is very flattering to me. In particular, I wish to emphasise the following points in which we are at one.

[1] *Medical Chronicle*, August, 1892.

1. The pain of which the patient complains always lies within the areas of tenderness, if these be present. Should they be present at one time and absent at another, but the pain remain, tenderness is always found to make its appearance in the area which is said to be painful.

2. The tenderness is not deep seated, but is purely cutaneous or subcutaneous. One of the best methods of eliciting it, is to pick up the skin gently between the finger and thumb. In addition, Mackenzie uses the point of a pin, but I generally use the broad blunt head of a large pin, especially where the area of skin affected lies over a bony substratum. Thus Mackenzie looks for the exaggerated expression of pain produced by the point of the pin over the tender area: whilst my method of stimulation produces no pain until the tender area is reached.

3. These areas of tenderness bear a definite relation to the different organs affected, but in many cases lie at a considerable distance from the organ affected. The pain produced by stimulation is not produced by any action on the organ itself, which may lie at a considerable distance from the tender spot. Again, the tenderness may be on the right side, though the organ affected lies on the left side of the body.

4. The superficial reflexes are usually exaggerated over the tender areas produced by visceral disease.

I shall now enumerate very shortly the areas which are affected in diseases of the various organs, and shall now use the segmental nomenclature I determined in the last section instead of the cumbrous names for the areas which were necessary before we had determined their significance.

The Heart and Aorta.

In diseases of the heart and great vessels, it is easy to get an account of the pain, but it is often difficult to demonstrate tenderness; for notoriously the most painful disturbances take the form of anginal attacks, in which the patient is not in a fit state to give an account of himself. Sometimes, as is well known, the pain radiates down the ulnar side of the

arm to the wrist or little finger, and sometimes it starts from this point and radiates up to the chest.

The first case I have selected for illustration, is that of a man, aged 40, who had suffered from attacks of pain three to four times a week. The heart was dilated and hypertrophied, and there was a double aortic and faint mitral systolic murmur. He first of all feels as if he were blown up with wind, then pain comes on under the left breast, and at the angle of the left scapula. It then appears at a point

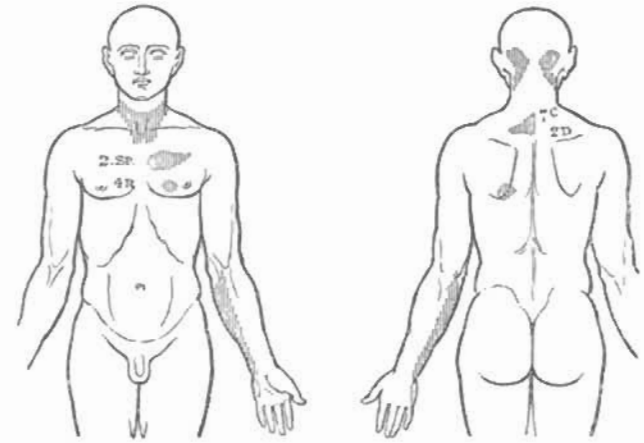


FIG. 21.

To show the areas of cutaneous tenderness during an anginal attack in a man with aortic disease (Case No. 22). They represent the whole of the 1st dorsal and 3rd cervical segments together with the maxima of the 4th dorsal.
2 Sp. is placed over the 2nd intercostal space.
4 R is placed over the 4th rib.
7 C at the level of the spine of the 7th cervical vertebra.
2 D at the level of the 2nd dorsal spine.

in the third space, just internal to the nipple line. In these attacks, a spot in the second space 3 inches from the middle line, and thence down the arm to the fingers, but not to the thumb. In the arm it darts backwards and forwards, sometimes upwards, sometimes downwards. I subsequently saw him in one of these attacks, and he then had intense cutaneous tenderness over the ulnar side of the forearm, back and front, over an area in the supra-spinous fossa at the level of

the second dorsal vertebra, and over an area in the second space extending from the nipple line to the mid-line of the chest. Thus the tenderness marked out very closely the area supplied by the first dorsal segment. In addition, he had pain and tenderness over the angle of the scapula, and over a point on to the fourth rib just internal to the nipple.

Case 22.—J. C., aged 40, draper's porter. Was in University College Hospital a few months before I saw him first with heart disease. The heart is now dilated and hypertrophied. Cardiac impulse strong. No thrill. Double aortic and mitral systolic murmur. Arterial pulsation up to ear. Capillary pulsation marked. Pulse 84, typically aortic regurgitant.

Suffers from attacks of pain as often sometimes as three and four in the week. He first feels blown up with wind, then pain comes on under left breast, and at angle of scapula. It then goes to a point just above the nipple; thence to a point in the second space from which it radiates down the arm to the hand. The ulnar side of the arm only is affected. After the pain in the arm comes on, he gets pain in the throat, with hoarseness and difficulty in speaking. In about an hour he vomits and brings up wind, and the attack is at an end.

On June 22, he had cutaneous tenderness (1) over the fifth rib internal to the nipple on left side. (2) Over the vertebral border of the spine of the scapula. (3) Over a point just internal to the angle of the scapula. (4) Over the ulnar side of the bend of the forearm. (5) Over the base of the hypothenar eminence in the left hand.

June 29. Came to U. C. H. in evening with a bad anginal attack. Attack began at 10.30 p.m. as described above. At midnight he was in great pain, face anxious and pale; great cardiac distress. Pulse could not be counted; was running and of very low tension.

There was intense cutaneous tenderness as in fig. 21, and the pain was referred entirely to the regions over which the skin was tender.

Voice hoarse. No cough. Pupils equal, about 5 mm. React normally.

He was put to bed and soon began to vomit. By 1 a.m., June 30, the attack was over.

At 8 a.m., June 30, he was well, and all cutaneous tenderness had practically gone. He left the Hospital to go to his work.

In the case of a man, aged fifty, who suffered from an aortic aneurism pointing to the region of the second rib, the tenderness was situated over the area shown in fig. 22, corresponding to the second, third, and fourth dorsal segments.

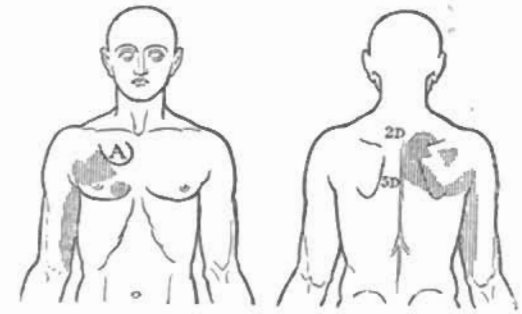


FIG. 22.

To show the areas of cutaneous tenderness in a man with aortic aneurism (Case 23). They represent the 2nd, 3rd and 4th dorsal segmental areas.
The outlined area A represents the extent of visible pulsation.
2 D is placed at the level of the spine of the 2nd dorsal vertebra.
5 D at the level of the spine of the 5th dorsal vertebra.

Case 23.—Edward T., aged 50, caretaker. U. C. H. [Dr. Roberts.]

November, 1890. Attack of gout. Pain in right side of chest and shortness of breath. By June, 1891, this pain had so increased that he could not walk without becoming short of breath and suffering from pain. July 15, U. C. H. Double aortic murmur, aortic pulse, aneurism of ascending and transverse portions of aorta diagnosed.

June, 1892, re-admitted. A little to right of middle line in first and second spaces is a swelling extending from the lower border of the clavicle to the third rib below. To the left it reaches the middle line of sternum; to right, nipple line. Surface of the pulsating swelling fairly regular except that there is a nipple-like projection in the centre.

Apex beat, fifth space half-inch outside nipple line. Diastolic aortic and less marked systolic aortic murmur over the swelling and over sternum.

Pulse 76, aortic. Pupils equal. No anginal attacks.

Pain on right side of chest:—

(1) in third space about 2½ inches from mid-sternum.

(2) Pain at extreme apex of axilla.

(3) And over a point behind at the level of the spine of the scapula a little to right of middle line.

July 3. Whilst singing hymns sudden increase of the pain and extension of the area of the aneurism; very marked cutaneous tenderness as in fig. 22.

Another case of dilatation of the aorta with dilated and hypertrophied heart showed the second dorsal segmental area in a very beautiful way. The maximum pain was situated

over the most posterior portion of the spine of the scapula and over the second space in front. This pain radiated down the arm, but did not go further than the elbow.

Mackenzie[1] gives a number of cases of cardiac disease showing pain and tenderness over these areas, and gives an excellent figure showing the whole area affected in such cases. He points out that in a large number of cases certain tender points make their appearance. A glance at plates I. and II. shows the segments to which they belong, according to my enumeration, but I will group these points according to the segmental areas of which they are the expression.

First Dorsal.— (*a*) Seventh cervical to second dorsal spine.
(*b*) Second space from nipple line to mid-sternum.
(*c*) Ulnar side of bend of elbow.

Second Dorsal.—(*a*) Over the spine and vertebral border of the scapula.
(*b*) Over the axillary border of the pectoralis major.
(*c*) Over the middle of the triceps muscle in the arm.

Third Dorsal.— (*a*) Over the middle of the scapula just below the spine.
(*b*) Over the third rib internal to the nipple line.

Fourth Dorsal.—(*a*) Over the third and fourth vertebral spines and outwards to the vertebral border of the scapula.
(*b*) Over the region in the axilla covered by hair.
(*c*) Just above the nipple itself.

Fifth Dorsal.— (*a*) Exactly over the angle of the scapula.
(*b*) Over the fourth rib and space internal to the nipple.

In cases of angina pectoris, whether there are physical signs of valvular disease or not, we frequently find that the

[1] *Loc. cit.*, fig. 4.

areas corresponding to the sixth and seventh dorsal roots are also affected. But in addition other areas belonging to the cervical plexus are also well marked. I shall therefore leave the full consideration of the phenomena of anginal attacks for my next paper on the head and neck. For in order to understand their full significance we must first know the distribution of the segmental areas of the cervical plexus.

Thus to sum up the results yielded by a study of cardiac disease :—

(1) In diseases of the heart, and more especially in aortic disease, the pain is referred along the first, second, third and fourth dorsal areas.

(2) In angina pectoris the pain may be referred in addition along the fifth, sixth, seventh and even the eighth and ninth dorsal areas, and is always accompanied by pain over certain cervical areas.

Lungs.

For the production of visceral pain, and especially of tenderness in connection with the pain the disturbance in the organ has to be fairly acute. Now with regard to the lung we labour under several disadvantages if we attempt to find tenderness associated with its disturbances. For the majority of cases which occur in our hospitals are chronic,

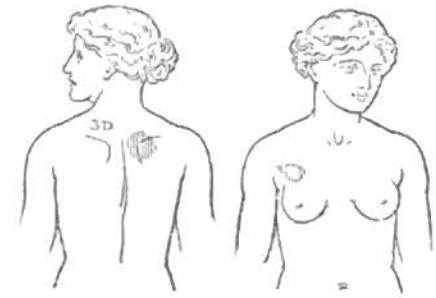


FIG. 23.

To show the areas of cutaneous tenderness in a case of acute bronchitis (Case No. 24).
These spots represent the maxima of the 2nd dorsal segment.

and those which are acute, such as lobar pneumonia, are not as a rule in a condition to give an account of themselves.

Fig. 23, however, shows the position of intense pain in a case of acute bronchitis. The pain was particularly bad on coughing. The areas in this figure also show the position of great cutaneous tenderness. The patient said she was so sore "she felt as if she had been beaten." The signs of bronchitis were far more marked on the right side than the left in this case.

Case 24.—Mrs. B., aged 34.

Pregnant seven months. Called to her on account of bad cough and pain in chest, which came on four days before. Temp. 103. Pulse 110. Respn. 30. Numerous mucous râles all over right side and also at left base. No dulness. Pain on coughing, associated with great cutaneous tenderness over the areas in fig. 23. Pressure over these areas, especially over the one in the back, seems to start the cough.

She subsequently aborted, and died June 8. No definite signs of pneumonia. Lochia normal. No pain or disturbance connected with uterus or other organs of the body.

With regard to phthisis which is the lung disease on which one has to depend, an enormous number of cases have neither pain nor tenderness. Some have pain and only a few have definite cutaneous tenderness. These as far as I have seen so far are those with an irritable cough in the early stage. Many will tell you they have suffered pain "but that has passed off now." Perhaps the commonest place is over the same areas as those in fig. 22. Another very common area to be affected is that of the sixth dorsal segment. The two main points of this area are situated the one posteriorly at the level of about the seventh dorsal spine just internal to the angle of the scapula and the other in front under the breast. The lowest area or the lowest two areas of the cervical plexus are also frequently affected. To these areas belong the tender points at the posterior aspect of the shoulder joint, and those over the second rib and under the clavicle. The inner side of the arm and the axilla are also sometimes affected, and not uncommonly the pain and even tenderness may extend down the ulnar border of the arm and forearm to the ulnar side of the hand.

The case mentioned on p. 34 shows the possible connec-

tion between the area of these referred pains and the area occupied by herpetic eruptions. A man of 34 years of age, with evident, though slight, signs of advancing phthisis at the right apex was accustomed to have pain and a sore feeling over the third dorsal spine and the spine of the scapula "whenever he caught cold" (*i.e.*, whenever his cough was worse). He came to me "having caught a fresh cold," and this time the pain to which he was well accustomed did not pass off but was followed by a herpetic eruption over the scapula and in the axilla corresponding to the area of the third dorsal segment.

Thus in diseases of the lungs the areas corresponding to the first, second, third, fourth, fifth, sixth and seventh dorsal segments may be affected. The second, third, fourth and fifth dorsal seem to be most commonly affected. There may also be pain and tenderness over the lower areas such as that of the seventh dorsal but in such cases there is frequently distinct evidence of dyspepsia, so common in the early stages of phthisis.

Œsophagus.

Stricture of the œsophagus affords one of the most definite instances of referred pain for here the pain can be produced by swallowing. In several cases the necessity for passing a bougie has been taken advantage of to discover the situation of the pain. As the bougie passes the patient is asked to mark out with a pencil the spots where the pain is situated. In most cases the pain is referred to a point about two inches from the middle line exactly at the angle of the scapula and is associated with a pain in front over the fifth space about half-inch internal to the nipple line. There is sometimes pain in the back over the sixth and seventh vertebral spines. Frequently pain thus referred is the only phenomenon but sometimes cutaneous tenderness is also present over the spots of referred pain.

One of the most marked cases I have seen was in a man of 65 years of age who in consequence of diet and treatment presented scarcely any pain. The stricture, which was fourteen

inches from the mouth, began to close and it was therefore determined to pass a bougie. After the passage of the instrument he complained of a good deal of pain and I found the whole of the fifth, sixth, seventh and eighth dorsal areas exquisitely tender. The curious upper border of the fifth dorsal area with its axillary flap was beautifully shown. By the next day this tenderness had subsided and was replaced by tender points only. These tender points in turn subsided one by one. He died a month afterwards of malignant disease of the œsophagus.

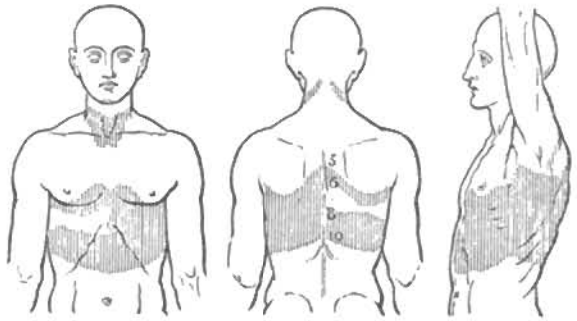


FIG. 24.

To show the areas of cutaneous tenderness in a case of stricture of the œsophagus, induced by the passage of a bougie (Case No. 25).

The areas represent the supply of the 5th, 6th, 7th, and 8th dorsal segments on the left side, and the 5th, 7th, and 8th dorsal on the right side. The upper border of the 5th dorsal is well shown on the lateral figure.

The numbers on the posterior view represent the spines of the respective dorsal vertebræ.

Case 25.—Samuel L., aged 64. (Mr. Heath, U.C.H.)

One month before admission difficulty in swallowing solids. Gradually getting worse. Now even liquids regurgitate. Healthy looking man. Somewhat wasted. When he attempts to swallow milk he makes efforts of deglutition for about 15 seconds and then milk comes up again.

Complains of pain at episternal notch and over a point in the fifth space just inside the nipple on both sides. Also sometimes in the back just internal to the angle of the scapula. Cutaneous tenderness more or less marked over all these points.

No physical signs of aneurism. Voice normal.

No physical signs in lungs or heart.

No enlarged glands. Liver not enlarged.

Took prepared foods well and became almost free from pain and cutaneous tenderness. June 8, an œsophageal bougie was passed

14 inches from teeth but it was found impossible to get it into the stomach. Tenderness the same evening as in fig. 24. Very similar results obtained on June 15 after similar abortive attempts to pass bougie.

Died in August of complete closure of maligant stricture.

As the bougie passes the patient frequently complains of "choking pains" at the episternal notch. I have occasionally, though rarely, found tenderness associated with this pain, marking out one of the lower cervical areas.

Thus the most prominent situation of pain and tenderness in stricture of the œsophagus corresponds to the distribution of the fifth dorsal, but the sixth, seventh and even the eighth dorsal segments are also frequently affected more or less.

The Breast.

Many factors combine to hinder the determination of the referred pain and tenderness due to disturbances of the breast. For it is notorious that the majority of tumours of the breast give no referred pain, and secondly, whenever a woman is run down, from whatever cause, she tends to suffer from a pain under the breast, associated with tenderness; moreover, the disturbance has to be fairly acute, or reference does not take place.

The most perfect example of referred pain in its purest form, was produced by retention of milk in one breast. Here there was marked cutaneous tenderness over the fourth and fifth dorsal roots. Fig. 25 was taken from a

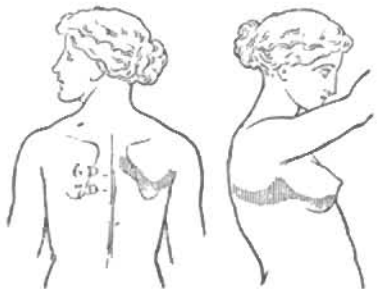


FIG. 25.

To show the distribution of cutaneous tenderness in Case No. 26. This area represents the distribution of the 5th dorsal segment.

young woman whose child was 4 months old. She suffered from sore nipples, and every time the child sucked she had pain over the angles of the scapulæ, over the posterior part of the axilla, and over the lower half of the breast. The tender area corresponded exactly with that of the fifth dorsal root.

Case 26.—Mrs. B., aged 34. Is suckling 4 months' old child. Right nipple was sore, and bled when the child sucked. This is now healed, but she complains of pain in the breast and pain in the back, between the posterior border of the scapula and the spine, on the right side, at about the level of the sixth or seventh dorsal spine. This pain is accentuated every time the child sucks. Marked cutaneous tenderness, as in fig. 25. No mastitis. Temperature normal.

It is not at all an uncommon thing for women who suckle children into the second year to complain of pain "over the tip of the shoulder blade." Mostly such women are debilitated and weakly, but I made the following observation in a strong healthy woman who was suckling an 18 months' child to prevent conception. She was free of pain or tenderness before she put the child to the breast, but after the child had pulled violently and vigorously at her breast for a few minutes, the pain over the shoulder blade began to appear. She let the child suck until he fell asleep, and by that time there was a distinct area of cutaneous tenderness over the lower border of the scapula. She was accustomed to let the child pull at the breast whenever he woke in the night, and she said that in the morning her shoulder blade was sometimes so sore she could not put on her stays.

Thus the principal pains and tenderness in disturbances of the breast gland and ducts (other than new growth) seems to be situated over the fourth and fifth dorsal roots.

Stomach.

Pain in gastric disturbances is almost always accompanied by some cutaneous tenderness. This tenderness lies in front between the level of the ensiform cartilage and the umbilicus. It occupies one or more of the three

areas corresponding to the supply of the seventh, eighth and ninth dorsal segments.

One of the commonest situations for pain is at the epigastrium, just over the ensiform cartilage, and a reference to plate Ia, shows that this is one of the maximum spots of the sub-scapulo-ensiform, or seventh dorsal area. In cases of so-called gastric ulcer, cutaneous tenderness is nearly always present over this area and over a point in the line of the angle of the scapula at the level of the ninth dorsal spine.

The middle area of this group (eighth dorsal) also appears frequently, but as far as my experience goes, seldom alone in stomach affections. It is nearly always associated with the one above or the one below it. Its characteristic tender point is situated over the eighth space, almost exactly in the mid-axillary line.

The next area, corresponding to the ninth dorsal root, is one of the commonest of all the stomach areas. It appears repeatedly in cases of gastric ulcer, either alone or in combination with one or more areas of the group.

It is a curious thing that all these areas associated with the stomach tend to appear bilaterally. This was so in a case of which fig. 26 was taken. It represents the cutaneous tenderness which appeared in a youth who was suffering from a violent attack of stomach pain, accompanied by vomiting, as a consequence of irritant food.

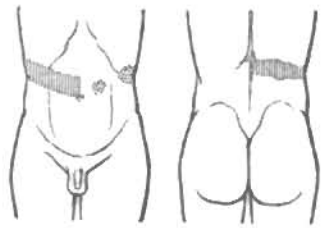


Fig. 26.

To show the distribution of cutaneous tenderness in a case of acute gastritis (Case No. 27). The area on the right side represents the full extent of the 9th dorsal area, whilst the spot over the costal border on the left side represents its most prominent maximum.

Case 27.—Youth, aged 14. Pain in the abdomen for the last twelve hours. Intense—keeps him doubled up. Points out position of the pain by placing the flat of his hand just above the umbilicus, with the fingers pointing to the linear alba. Cutaneous tenderness (blunt end of pin called "prick") over the area in fig. 26.

Bowels open. No constipation or diarrhœa. Has vomited several times.

Pain and tenderness gone next day.

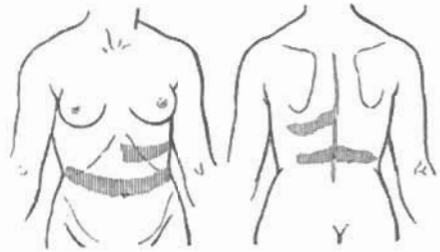


FIG. 27.

To show the distribution of cutaneous tenderness in a case of so called gastric ulcer (Case No. 28).

The areas on the left side represent the distribution of the 7th and 9th dorsal segments. That on the right side represents the distribution of the 9th dorsal segment.

Case 28.—M. E., aged 27, single, servant.

Two years ago attack of pain and vomiting. No blood. Recovered almost completely, but was subject to pain after food.

November 4, 1891, felt sick, and at 8.30 a.m., vomited large quantity of altered blood. Next day passed half pint of black stuff by bowel.

Constant cutaneous tenderness, mostly situated over the upper area; increased by food or by anything warm, but never quite absent. Pain referred to ensiform cartilage and to the back.

Vomits soon after food. Bowels confined.

Somewhat anæmic.

I cannot yet say whether the tendency for these areas to appear on the right side in stomach affections has any significance.

I do not think it is possible at present to say whether the appearances of one or other of these areas of tenderness has any value in differential diagnosis. However the uppermost one (seventh dorsal) seems particularly to appear in anything which causes vomiting [compare Case 1, page 11],

and when it appears as a sequel to vomiting it is frequently accompanied by the area next above it, corresponding to the sixth dorsal. Now we saw above that this sixth dorsal area was associated with disease in the lower part of the œsophagus, and hence I feel inclined to think that when both areas are present the disease is somewhere near the cardiac orifice. In the same way the ninth dorsal area is shared by both the stomach and intestine, and thus a lesion of the stomach causing pain over this area is probably situated nearer to the pyloric orifice; I possess, however, no records of *post-mortem* examinations to prove this, and at present it is a pure supposition.

In cases of gastralgia and gastic ulcer in which the pain bears a definite relation to the ingestion of food I think I am justified in making the following statement as regards the length of time after food at which it comes on. In those cases where the seventh dorsal segment is affected and the maximum tenderness is situated at and around the ensiform cartilage the pain comes on within half an hour after the food is swallowed. On the other hand in cases where the ninth dorsal segment only is affected the pain does not come on until the food has been swallowed at least an hour. This again tells in favour of the view that the seventh dorsal segment supplies the cardiac end of the stomach whilst the ninth dorsal supplies the pyloric portion.

Thus the areas which are affected in disturbances of the stomach correspond to the supply of the seventh, eighth and ninth dorsal segments.

Intestine.

The pain of intestinal affections is frequently quite diffuse and ill-defined. In fact it is not referred at all. Such pain is unaccompanied by tenderness in the skin. On the other hand a considerable number of cases of intestinal disturbance exhibit well marked pain and tenderness. I watched a large number of cases of diarrhœa which occurred in out-patient practice, and, as far as my experience goes at present, found that those cases in which "rolling," "griping," "doubling

up pain" was complained of there was no pain in the back and no cutaneous tenderness. On the other hand a fair number of cases of acute diarrhœa, either due to some direct irritant, such as improper food, or more rarely to the disease known as "summer diarrhœa" were associated with pain below the umbilicus and over the twelfth rib, marking out to a greater or less extent the area supplied by the tenth dorsal segment. In those cases associated with a direct history of irritant food, I found the area corresponding to the ninth segment was also tender. If vomiting occurred in association with this diarrhœa, all the areas from the seventh to the tenth dorsal inclusive, might be present to a greater or less extent.

On the other hand the majority of cases of summer diarrhœa in which the stools were like "black water" complained of no referred pain, and did not show cutaneous tenderness.

It is also noticeable that cases of lead colic do not complain of referred pain and do not show cutaneous tenderness, even when the onset is fairly acute, and the "griping" pain well marked.

I feel inclined to think the pain and aching in the back loins and abdomen which appear in typhoid fever, is sometimes referred intestinal pain. In the case 52, there was at one time well-marked tenderness in the skin corresponding to the 10th dorsal area only. I have since seen several cases of typhoid fever, in which there was well-marked cutaneous tenderness over the abdomen and loins on both sides at the end of the second week of the disease.

Fig. 28 is taken from a man of thirty-nine, who suffered from dysenteric diarrhœa with fluid dark brown offensive stools, frequently containing blood. He was much relieved by enemata of creolin, but just after the injection he suffered a good deal of pain accompanied by exquisite cutaneous tenderness as shown in the figure. So tender was his abdomen, that he was obliged to have the clothes supported by a cradle. The tenderness varied from time to time; sometimes it occupied only the area of the tenth dorsal segment, sometimes that of both the tenth and

eleventh segments. Pressure relieved this pain, and to show how purely superficial it was, I may mention that it was completely removed by an ointment containing thirty grains of cocaine to the ounce of lanoline.

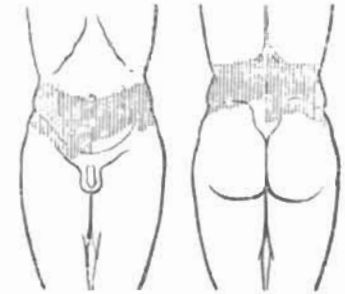


FIG. 28.

To show the distribution of cutaneous tenderness in Case No. 29. The area on the left side represents the 10th dorsal; that on the right side the 10th and 11th dorsal.

Case 29. Edward B., aged 39, compositor. (U. C. H., Dr. Roberts).

Eight months before admission had an attack of diarrhœa in which he passed blood. Lasted six weeks. Diarrhœa never quite ceased.

On admission pale, very thin, skin dry.

Appetite good, tongue large, flabby, not furred. No nausea or vomiting. Stools fluid, dark brown, very offensive. Contained altered blood in considerable quantities. Sometimes stools were quite fluid, sometimes they contained a few hard lumps. Abdomen distended.

No physical signs in lungs or heart.

Complained of a great deal of pain in the abdomen below the umbilicus, and in the back below the twelfth dorsal spine.

There is great cutaneous tenderness, worse at one time than at another. Always situated in the areas of the tenth and eleventh spinal segments, but sometimes worse on one side, sometimes on the other. So tender is he, that the bedclothes are supported by a cradle. Yet firm deep pressure relieves, rather than aggravates, his pain.

Under creolin enemata and oil injections he improved, and left the hospital, passing liquid stools free of blood and free from pain. Tenderness absent.

Died at home two months afterwards.

In this connection a case of malignant stricture of the splenic flexure (autopsy) is instructive. The maximum tenderness was over the tenth dorsal with some tenderness over the eleventh dorsal area. These areas were I take it, of intestinal origin. In addition she suffered from very marked dyspepsia with flatus and occasional vomiting, and both the seventh, eighth and ninth areas are more or less tender (stomach). In addition she developed bronchitis with troublesome cough and expectoration, and it was from this that she actually died. With the advent of bronchitis she developed great tenderness in the upper part of the back, between the spine of the scapula and the third to fourth vertebral spines, the point corresponding to the second dorsal area.

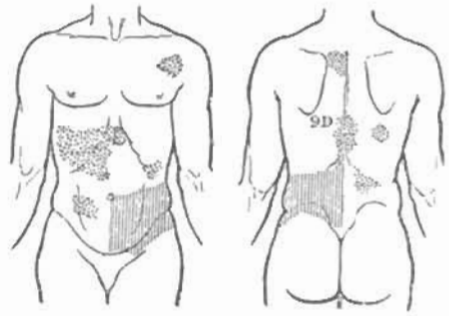


FIG. 29.

To show the distribution of cutaneous tenderness in a case of stricture of the sigmoid flexure of the large intestine (Case No. 30). The shaded area represents the 10th and 11th dorsal. The dotted areas are the same on the opposite side, and represent its maximum spots. The dotted area in the region of the liver represents the 7th and 8th dorsal. The dotted areas in the region of the spine of the scapula, and the front of the chest represent the maxima of the 2nd dorsal.

Case 30.—E. W., aged 46, U. C. H. (Mr. Heath), June, 1891.

Four years ago began to feel "fulness" in lower part of bowel.

Three years ago motions began to get smaller and passage gave her pain. Constipation alternating with diarrhœa.

November, 1890, passed blood from rectum. This has continued on and off ever since.

Losing flesh lately.

On admission abdomen much distended. Marked cutaneous tenderness over left half of abdomen below umbilicus as in fig. 28. This was probably due to the distension of the gut produced by the stricture and not to the destruction caused by the malignant disease itself. Some ill-defined tenderness on right side. Liver felt 3in. below costal border.

Considerable cutaneous tenderness in the region of the liver and back as in fig. 29.

Early pneumonic signs. Large râles and increased vocal resonance, especially left side. Much cough and some expectoration.

Note the spots of tenderness in the upper part of chest.

June 17. Difficulty in passing urine, and diarrhœa came on.

August 1. Died somewhat suddenly.

Post-mortem.—Intestines matted with recent lymph. Fluid in abdomen. A large mass of new growth involves sigmoid flexure. Large intestine and cæcum distended. Liver much enlarged; many small secondary growths. Gall bladder contains large number of stones. Left pleura full of fluid. Left lung collapsed.

Thus a certain number of cases in which the intestine from the pylorus to the end of the colon was affected showed definite cutaneous tenderness, corresponding more or less to the ninth, tenth, eleventh and possibly twelfth dorsal areas.

Liver and Gall Bladder.

The pain of liver disease is difficult to work out satisfactorily, for in those cases which are accompanied by pain the diagnosis of uncomplicated liver disease is not always satisfactory. Moreover a large number of cases of disease of the gall bladder which come to operation or autopsy are in reality secondary to malignant disease. In this connection the following case, for which I am indebted to Dr. Ringer, is very instructive. He was aged 47, and in July '91 began to suffer for the first time from severe attacks of biliary colic followed by jaundice. In January he was admitted, suffering from considerable pain, with cutaneous tenderness over the eighth and ninth dorsal areas on the right side, and the sixth and eighth dorsal areas on the left side. The tenderness was well defined, and on his left side the curious relation borne to one another by the sixth and eighth dorsal areas in the axillary line was beautifully shown. He was not jaundiced, but there was a trace of bile

in the urine. A mass could be felt under the right costal margin, which was rightly supposed to be gall bladder. Mr. Pollard operated and removed 138 gall stones. All the old pain and tenderness disappeared and never returned, but secondary growths made their appearance in the lungs and skin, and he died on February 11th. A large mass of new growth was found in the portal fissure, blocking the bile ducts. Now although there was malignant disease I cannot help thinking that the pain and tenderness were due to the gall stones, for the pain exactly resembled that in cases of biliary colic in which gall stones pass, and it disappeared entirely after the operation although the malignant disease was untouched.

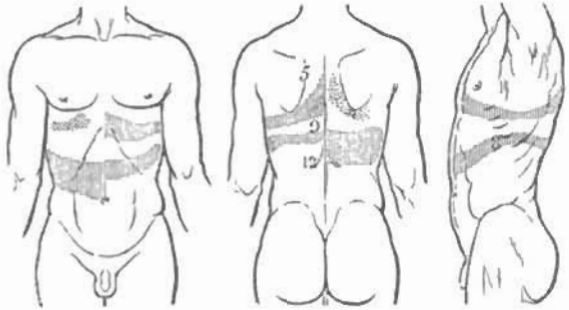


FIG. 30.

To show the extent of cutaneous tenderness in a case of hepatic colic (Case No. 31).

The areas represent the distribution of the 6th and 8th dorsal on the left side, and the 8th, 9th, and part of the 6th dorsal on the right side.

The figures on the posterior view are placed at the level of the spines of the vertebræ. The figure 8 on the lateral view is placed over the 8th intercostal space.

Case 31.—Frederick C., aged 47, tailor. U. C. H. (Dr. Ringer).

July, 1891. Several attacks of gallstone colic followed by jaundice. The attacks came on daily or there might be a week between the attacks. In the intervals pain in the right side. Stools greyish white during the attacks. Was perfectly well up to July.

Jan. 1892, admitted. Emaciated and pale. No jaundice. Continuous aching pain in right hypochondriac region. Tongue furred. Liver not felt. Below ninth costal cartilage an indistinct mass can be felt. Bowels confined. Motions normal colour. Urine contains a trace of bile. No vomiting.

Intense cutaneous tenderness so great that the head of a pin is felt as a sharp point, and he says that he is being pricked when touched over the areas marked in fig. 30.

Jan. 9. Mr. Pollard operated. Extensive adhesion round gall bladder.

Jan. 14. Mr. Pollard removed 138 gall stones from the bladder.

Jan. 15. All old pain gone. No sign of cutaneous tenderness. Slight pain in the wound only.

Feb. 9. Cough. Pneumonic signs left lung.

Feb. 11. Died.

Post-mortem.—Bile ducts surrounded by dense firm tissue. At portal fissure large mass of new growth. Growth limited very closely to Glisson's capsule. No scattered masses in liver. No new growth in gall bladder. Common bile duct and cystic duct were patent. Numerous small growth in omentum. Stomach, intestine, spleen, kidneys normal. Lower lobe of left lung solid. Pneumonic patches; gangrene of extreme lower part.

The well known pain in the back at the level of the eleventh dorsal spine extending outwards to the line of the angle of the scapula and associated with pain "over the gall bladder" are simply the maximum spots of the eighth dorsal area. The eight dorsal segment seems to be particularly associated with the gall bladder and I believe it is for this reason that this area shows a greater readiness to appear on both sides in biliary colic than any of the other areas associated with the liver.

In this description of the pain and tenderness in association with gall stones I am in almost complete accord with Mackenzie.

In some cases of liver disease such as the enlarged and congested liver of primary, and not of secondary, origin the tenderness takes one segment lower than in cases of gall stones. The whole of the tenth dorsal area is more or less tender. Makenzie expresses a doubt as to whether this is not due to perihepatitis but I think I have satisfied myself that there is this cutaneous tenderness between the twelfth rib and the crest of the ilium. These cases also show the spot in the eighth space and mid-axillary line so common in liver disease.

Again, disturbances of the liver are associated with pain and sometimes tenderness over the shoulder joint and over

the neck corresponding to the distribution of the lower roots of the cervical plexus; but I have not yet satisfied myself of the diagnostic significance of this pain in the lower part of the neck.

Thus in disturbances of the liver the pain is referred to, and the tenderness appears over, the areas supplied by the eighth and ninth dorsal segments and sometimes over that of the tenth dorsal on the right side. If the gall bladder is affected the pain and tenderness also lie over the eighth and ninth dorsal areas but the fifth, sixth and seventh are as a rule also implicated more or less.

Kidney and Ureter.

The pain of renal calculus is most useful for this investigation; for the diagnosis of stone in the kidney is practically always confirmed by operation.

The pain is said to be situated about the tip of the twelfth rib in the loin behind, and over a point in the abdomen internal to the crest of the ileum. During an attack of colic the pain is said to shoot round "the lower part of the back" (about the first lumbar spine) to the front of the abdomen and thence to the thighs and even down to the inner side of the knee. This pain is associated with marked cutaneous tenderness especially after an attack of colic. After an attack the patient complains that he feels "bruised, just as if he had been beaten about the back and loins." Mostly the area of tenderness is the tenth dorsal but sometimes the eleventh and twelfth dorsal areas are affected. Occasionally even some portion of the first lumbar with its spot on the inner side of the knee is marked out in tenderness.

One patient gave me the following interesting account showing the difference between an attack of renal colic in which no stone passed and one in which he actually passed a stone.

I first saw him just after an attack. The pain was located over the tip of the twelfth rib and on part of the crest of the ileum. The whole loin was sore and tender over an area marking out the tenth, eleventh and twelfth dorsal areas. No calculus had passed. Sometime before this he

had had an attack which was similar excepting that the pain gradually spread from the region of the tenth dorsal to the upper sacral region and to a point in front just above Poupart's ligament 2 to 3 inches from the middle line (maximum of eleventh dorsal). Then it spread down the inner side of the thigh to the knee; then to "the bottom of the back" through the perineum to the urethra. In this attack his doctor said he passed a uric acid calculus.

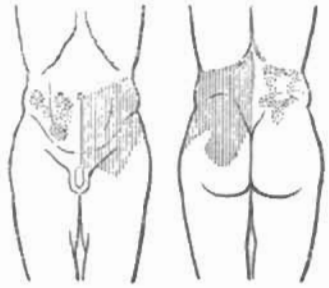


FIG. 31.

To show the distribution of cutaneous tenderness in a case of severe renal colic (Case No. 32).

The shaded area on the left side represents the 10th, 11th, and 12th dorsal. The dotted area on the right side represents the less defined tenderness associated with the presence of the maxima of the 10th and 11th dorsal areas.

It is interesting to note that this case showed a rather wider distribution downwards [11th and 12th dorsal] than is usual in cases of renal calculus in the inter-paroxysmal period. This was possibly due to the impaction of the stone in the ureter.

Case 32.—Thos. D., aged 37. U. C. H., June 30, 1891 (Mr. Hill).

Eight years ago passed a stone of a slate colour and the size of a bean. Pain came on after a long railway journey and lasted for twenty-four hours when the stone passed.

Was free from pain for a year and then began to pass crystalline masses, some of which were the size of a pea and were covered with minute points. On analysis they were said to be uric acid.

For three years he had about one attack of pain a year and passed small calculi. Lately the attacks have been more frequent. Blood always appears in urine after passage of calculus.

When I saw him he had just had an attack of colic, but no stone had passed. The pain starts behind at about the tip of the twelfth rib and runs forwards to a point in the left iliac fossa. Thence it passes to an intense centre of pain situated just above the internal ring. Thence it passes to another very painful focus

in the pubic hair close to the root of the penis. Thence it runs down the inner side of the thigh to end at about the lower third of the inner aspect above the knee. As soon as the pain reaches the point over the pubes retraction of the testicle takes place. He says the pain is like that of cramp and at the same time there is pain as if he had taken a strong purgative.

During the paroxysm certain points are excessively sore. The testicle is very painful and tender, but he says the scrotum is never sore.

When I first saw him he was suffering from great pain in the left loin and lower part of abdomen and groin.

There was marked cutaneous tenderness with exaggerated superficial reflexes on the left side as in fig. 31. There was also some tenderness of a less defined character in the right loin and abdomen.

This cutaneous tenderness does not affect the scrotum except perhaps at its extreme upper part, *i.e.* the greater part of the skin of the scrotum is not tender. But the left testicle is intensely tender, and he cannot bear even the slightest touch.

July 1. Mr. Hill removed a calculus weighing six grains from the left ureter.

Seen again April, 1892. Wound healed. Has remained free from pain. No tenderness.

Case 33.—Geo. H., aged 24. U. C. H., June, 1891 (Mr. Hill).

Pain in left loin and across front of abdomen for five to six years. Agonizing attacks about once a month. Blood in urine, especially after an attack.

On admission.—Abdomen flaccid. Lower end of left kidney felt; does not seem to be enlarged.

Urine: amber coloured; acid. Microscopically contains blood and urate of soda.

The pain radiates from the tip of twelfth rib behind to a point in the left iliac fossa about midway between the anterior superior spine and the umbilicus and a little below the level of the umbilical line.

Definite cutaneous tenderness over the area of the tenth dorsal spinal segment. The tenderness is especially marked over the tip of the twelfth rib behind, and over the point on the left iliac fossa to which he refers his pain.

June 17. Mr. Hill removed an oxalate of lime calculus from the left kidney. It lays free in the pelvis and weighed twenty-seven grains. Dark coloured, ovoid stone, flattened from side to side and studded with small nodules.

Oct. 28. Has remained free from pain. No tenderness. Is in excellent health. Urine normal. No blood. Scar looks perfect.

In a patient with a floating kidney, who had no pain or tenderness as he lay in bed, I have seen the characteristic pain at the tip of the twelfth rib with cutaneous tenderness

over the area of the tenth dorsal, produced by the rough manipulation of an examination.

Thus the kidney is particularly associated with the cutaneous areas of the tenth, and to a less extent those of the eleventh and twelfth dorsal and first lumbar areas. On the other hand, diseases of the pelvis of the kidney and of the ureter, seem to be particularly associated with the eleventh and twelfth dorsal and first lumbar areas.

Testis.

The testis is not so satisfactory as the kidney, owing to the great tendency of diseases of this organ to produce "spreading." (*Vide* chapter iv.)

In the case of a youth in whom one testicle had not descended, but lay in the inguinal canal, I made the following observations. In the course of his work he knocked it against a bench and it swelled and became painful. The pain was situated at the tip of the twelfth rib behind, and just internal to the crest in front, oddly enough on the opposite side, mainly, to the affected testicle. There was great superficial tenderness over the area of the tenth dorsal segment.

Case 34.—George D., aged 16. U. C. H., Jan., 1891 (Mr. Barker).

Is a carpenter, and pressure on the bench causes great pain in the undescended right testicle.

No testicle in right half of scrotum, but just to the inner side of the external iliac artery is a soft roundish swelling. When pressed upon it gives him testicular sensation. When he stands up index finger can be inserted into external abdominal ring, and the lower end of the swelling can be distinctly felt. In the erect posture it comes lower and can be pressed against the crest of the pubes. This gives him great pain.

The testicle itself is very tender, but the cutaneous tenderness on the occasion on which I saw him marked out the tenth dorsal area on the left side (not the right as might have been expected).

Mr. Barker removed the testicle, and he left the hospital Feb. 5, free from pain.

Again in cases of true traumatic orchitis when acute, there is intense pain over the loin and sometimes tenderness in the area of the tenth dorsal segment.

Thus the testicle seems to be peculiarly associated with the tenth dorsal spinal segment.

Epididymis.

Epididymitis is mostly gonorrhœal in origin and is associated with considerable pain when acute. In an ordinary moderately acute case the pain is situated over the fifth lumbar and first sacral spines behind and just over about the internal inguinal ring in front. These spots are generally tender and correspond to the maximum of the eleventh dorsal area. Sometimes the pain and tenderness are as in fig. 32, and thus correspond to both the eleventh and twelfth areas.

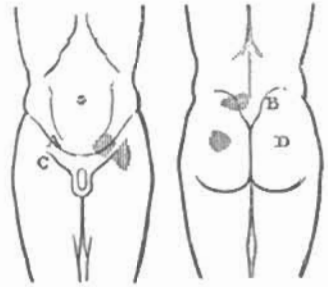


FIG. 32.

To show the cutaneous tenderness, and at the same time the seat of the pain and aching in a case of gonorrhœal orchitis (Case No. 35).

The spots marked A and B, correspond to the maxima of the 11th dorsal area. The spots marked C and D correspond to the maxima of the 12th dorsal area.

Case 35.—S. K., aged 28. U. C. H., casualty department, May, 1892. Had a "running" for nine weeks. It stopped a week ago, and next day swelling came on in "privates." Now well marked epididymitis. Left epididymis swollen to size of small apple, and very tender.

Pain passes from the point D (fig. 32) to B, and thence round the crest to the lower part of the abdomen and upper part of the groin. It is not sharp or shooting, but is dull and aching, "as if someone had kicked him." Cutaneous tenderness, as in fig. 32.

It is a noticeable and instructive fact that although the epididymis is exceedingly tender to manipulation, there is no cutaneous tenderness of the scrotum. Thus there is frequently considerable cutaneous tenderness over the outer border of Scarpa's triangle in a situation far removed from any of the affected structures, but no cutaneous tenderness over the epididymis itself [*i.e.*, scrotum], excepting at the upper portion, where the skin is supplied from the twelfth dorsal segment.

If the epididymitis is very acute, the tenderness may become very extensive, reaching to the inner side of the knee and the outer side of the thigh, and it may even spread into the perineal area, jumping from the lumbar supply to that of the sacral areas.

Case 36.—Peter W., aged 40. U. C. H. (Mr. Heath), August 30, 1891. Denies gonorrhœa or syphilis.

August 27. Gnawing pain in left testicle.

August 30. Considerable swelling of left testicle, both body and epididymis. Epididymis hard, nodular, tender. Body also swollen, a little harder than natural and very tender. Spermatic cord as a whole thickened. Skin of scrotum reddened, and a little œdematous. No urethral discharge. Prostate normal in size and consistency. Temperature rose to 100.6.

Pain starts from the lower lumbar and upper sacral region, extending laterally on to the buttock. It also extends down the outer and inner aspects of the left thigh, and on to the abdomen above the pubes.

Intense cutaneous tenderness marking out the eleventh, twelfth and first lumbar areas.

September 7. All pain gone excepting in groin. No marked tenderness.

Thus the epididymis seems to be particularly associated with the 11th and 12th dorsal segments.

Bladder.

Erichsen states that the pain of stone in the bladder "may be experienced not only in the region of the bladder and perineum, but may radiate widely in the course of the nerves of the lumbar and sacral plexus, the patient complaining of a heavy dragging sensation in the groins, extending down the outside and back of his thighs and not uncommonly experienced in the soles of the feet."

I have met with no case, so far, which showed this wide distribution. The patient usually complains of pain in the

perineum—pain at the end of the penis and pain over the ischial tuberosities. Sometimes this pain is accompanied by tenderness. Fig. 33 shows that this pain represents the gluteo-perineal (third sacral) area, for the patient complains exactly of this pain, and the tenderness occupied the area in the figure. The pain was caused by the unfortunate removal of a piece of mucous membrane of the bladder, during the crushing of a phosphatic calculus.

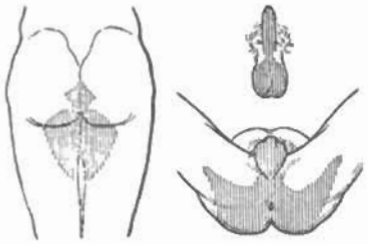


FIG. 33.

To show the cutaneous tenderness in a bladder case (Case No. 37).
The shaded areas represent the 3rd and 4th sacral. Note that there is a small patch of skin at the base of the scrotum which is unaffected. This is supplied from the 12th dorsal.
Compare with this figure the distribution of the eruption shown in fig. 10.

Case 37.—Wm. Thos. C., aged 51. U. C. H., May, 1892. Twenty years ago gonorrhœa. Two years afterwards developed a stricture. Up till six months ago had been in the habit of passing a catheter.

April 24. Could not pass any urine. No instrument could be passed into the bladder. Under opium and hot baths, No. 5 French passed the same evening. Urine alkaline, foul mucus, pus crystals of triple phosphates and micrococci.

He was slowly dilated, and on May 23 calculi were detected in the bladder.

May 24. Complains of pain before and during the passage of urine, but none afterwards. The pain is situated a little to the left of the anus and in the perineum. There is no cutaneous tenderness.

May 25. Two small stones ($\frac{3}{4}$ inch and $\frac{1}{2}$ inch in diameter) were crushed. The second stone gave considerable trouble, and on more than one occasion a small piece of mucous membrane was brought away in the blades of the lithotrite. Bleeding was considerable.

May 26. 9 a.m. Rigor.

May 27. Frequency of micturition; every hour and a-half to two hours. No blood; some pus and mucus.

May 28. Frequency of micturition continues. He complains of over the following points:—

[1st] Over the coccyx.

[2nd] Over a point on the inner aspect of both thighs, just external to the outer border of the perineum.

[3rd] Pain also in middle of perineum, "running down the passage" to the tip of the penis.

There is no pain above the pubes.

There is intense cutaneous tenderness in the extreme lower part of the spine, and in the perineum, as in fig. 33. The skin of the penis and scrotum is tender. Temperature normal.

May 29. The cutaneous tenderness was marked out again, and coincided with that in fig. 33.

June 3. Temperature normal since May 27. Another small stone (size of hazel nut) was crushed. Several small portions of soft tissue were removed from the bladder by the evacuator, evidently pieces of mucous membrane which had remained in the bladder since last operation.

Tenderness over a similar area was also produced by the accidental use of carbolic lotion instead of boracic, to wash out a patient's bladder. The whole glans, which had not been touched by the fluid, was intensely sore. Thus the ordinary pain due to lesions of the mucous membrane, seemed to correspond to the areas of the fourth and third sacral segments.

In cases of retention, however, an additional pain is found. Suppose a patient suffers from simple obstructive retention, the result of a stricture in a man, or better still, the tilting forwards of a fibroid or of the pregnant uterus in a woman, the bladder gradually fills, and a dull aching pain appears over the lower part of the sacrum, passing into the perineum. This pain is more or less continuous, and is described by women who have borne children as like the pain "at the very bottom of the back" in labour. Every now and then the patient is overcome by an irresistible desire to pass water and strains against the obstruction. And now a quite different pain appears, of a sharp, shooting character, radiating from the lower lumbar and sacral regions behind, round the ileum to the lower part of the abdomen just above the pubes, and also down the inner side of the thigh to the knee. This lumbar pain soon goes, only to

return again after an interval; but the sacral pain seems to be continuous. In all my cases the pain was completely relieved when the urine was drawn off. One of my female patients had retention several times, owing to the displacement of a large loose fibroid, causing pressure on the neck of the bladder. Each time she gave exactly the same description of the dual nature of her pain. She was always relieved by the passage of a catheter. The amount drawn off varied on different occasions from 40 to 60 fluid ounces.

Case 38.—Mary D., aged 34 years, married. U. C. H., obstetrical department.

August 22. Complete retention of urine for nearly twenty-four hours. Bladder reached to within an inch of the umbilicus.

She was in intense pain. The pain radiated from the lower part of the sacrum and coccyx into the perineum. It resembled a labour pain, and was accompanied by a feeling of weight and "bearing down" in the perineum.

When she strained to pass water this pain was joined by a pain over an area extending from the region of the fifth lumbar and first sacral vertebræ outwards, between the great trochanter and the crest of the ileum to the lower part of the abdomen and groin. It also extended on to the outer side of the thigh, and also down the inner side of the thigh to a point a little below the junction of the middle and lower thirds of the femur. This pain rapidly passed off, but recurred again and again whenever she tried to pass water.

No cutaneous tenderness.

Forty-one ounces of urine drawn off. Pain immediately relieved.

A large fibroid was felt, which had fallen forwards over the neck of the bladder.

She came up on two subsequent occasions, with retention from the same cause, and always complained of the two forms of pain.

Thus lesions of the mucous membrane of the bladder affect the lower sacral areas (third and fourth), whilst the pain of ineffectual contraction is difused over the eleventh and twelfth dorsal and the first lumbar areas.

Prostate.

Before I leave the male urino-genital tract I must mention the pain caused by diseases of the prostate. I have reserved this section to the last owing to the wide distribution of the pain in diseases of this organ.

The most marked pain is, as usual, caused by acute inflammation of the prostate—acute prostatitis.

The highest pain is situated over the twelfth rib behind and just internal to the crest in front. Pain may be present over the fifth lumbar spine behind, and also over the internal ring area in front, but I have no case where any lower dorso-lumbar areas were affected.

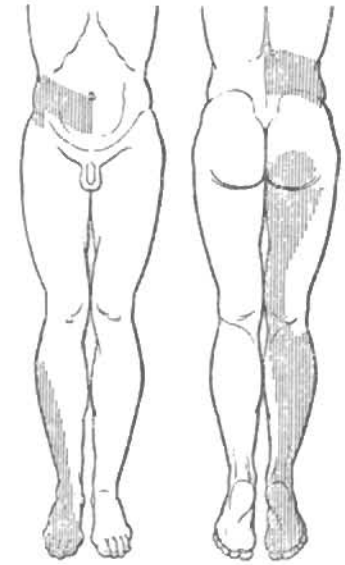


FIG. 34.

To show the distribution of cutaneous tenderness in a case of acute inflammation of the right lobe of the prostate (Case No. 39).

The uppermost area represents the supply of the 10th dorsal segment. The area on the back of the leg represents the 3rd, 2nd and 1st sacral from above downwards, and the area on the outer side of the leg the 5th lumbar.

But the patient also has pain over the lower part of the sacrum, and the ischial tuberosities over the upper part of the calves and over the soles of the feet, especially at the root of the great toe. One of my patients whose prostatitis was set up by improper instrumentation at the hands of a quack, said, "My life is a burden for I cannot stand owing to the pain in the soles of my feet, I cannot walk owing to the pain in the calves, sit on account of the pain over the

ischial tuberosities and in the perineum, or even lie owing to the pain in my loins and side."

If the prostatitis is fairly acute tenderness is present over all the areas corresponding to this distribution of pain—the tenth and eleventh dorsal, the first, second and third sacral.

In the case from which fig. 34 was taken, the tenderness was very well marked and the surgical report was "right side of prostate only, enlarged and tender."

Case 39.—Thos. T., aged 52, shampooer, casualty U.C.H., August 23, 1891.

Five weeks before he had retention of urine from a large prostate. No. 10 catheter passed. Came up August 21st, second attack of retention. Catheter again passed. Next day great pain. August 23, pain referred to spots in fig. 34, with cutaneous tenderness. Right lobe of prostate swollen, enlarged, and very tender. No prostatic discharge. Six weeks afterwards under treatment had lost all pain and tenderness in the skin and right side of prostate had subsided.

Thus the pain and tenderness when present in prostatic disease seem to belong partly to the dorsal and partly to the sacral areas. The dorsal areas most often affected are those corresponding to the tenth and eleventh dorsal segments. The lumbo-sacral areas which are affected correspond to the first, second and third sacral with sometimes the fifth lumbar in addition.

Ovary.

Ovaritis is the bugbear of the gynecologist owing to the general disturbances it is liable to produce. I shall therefore not describe the pains of ovaritis in detail, but only such pain as can be distinctly traced to the ovary.

During vaginal examination no pain is caused by taking a normal ovary between the fingers but a curious sensation is produced apparently akin to "testicular sensation." If however the ovary is inflamed very definite pain is produced which the patient localises in the loin behind and pain is also frequently referred to a point just below and to one side of the umbilicus. This pain is frequently accompanied by tenderness of the skin over the area of the tenth segment. When obstetric assistant I frequently found cases of ovaritis quite without tenderness. But after examination these same cases often showed marked cutaneous tenderness corresponding to the tenth dorsal area and to that area only.

Case 40.—Annie D., married. U.C.H. (Dr. Spencer) Aug. 1891.

Well developed healthy woman.

Nothing felt from abdomen. Body of uterus retroverted. Both ovaries prolapsed and easily felt. Both tender, right one more so than left.

Pressure on right ovary causes pain in the loin a little to the right of the middle line at the level of the second lumbar vertebra and pain in front about 1½ inch to the right and 1 inch below the umbilicus.

Cutaneous tenderness especially after examination accurately marking out the supply of the tenth dorsal segment. It shows the little downward tag just external to the anterior superior spine on both sides. The lower border of the tender area is 2 inches above the pubes in the middle line.

Case 41.—Mrs. V. U.C.H. (Dr. Spencer), Aug. 21, 1891.

Constant pain in left loin and in abdomen below the umbilicus. At menstrual periods has pain in addition over the lower part of the abdomen and down the back of the leg.

A prolapsed ovary is felt lying directly behind the uterus. It is excessively tender. Even the lightest pressure causing pain. This pain is referred to a point in the left loin corresponding roughly with the tip of the twelfth rib. It is also referred to a spot in front a little to the left of and below the umbilicus.

Intense cutaneous tenderness marking out in a beautiful manner the tenth dorsal area.

Thus the ovary like the testis causes referred pain and cutaneous tenderness along the tenth dorsal area.

The Appendages.

It is needless to mention that pressure on normal tubes causes no pain. But in some cases of salpingitis very definite pain is caused by manipulation. This pain is situated over about the fifth lumbar and first sacral spines and "in the groin" above Poupart's ligament.

After removal of the ovaries the stump is sometimes tender. In the case I have figured fig. 35, some ovary and the whole tube was left on the one side (right) and the whole ovary and part of the tube removed on the other side.

Spontaneous pain was almost completely absent and the patient was bright and intelligent. After examination she had some pain and developed the tenderness over the areas in the figure (fig. 35). Thus pain and tenderness from the ovary seem to follow a line corresponding to one segmental area higher than that from the tubes. This I believe to be a valuable point in diagnosis.

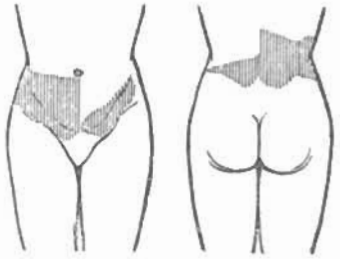


FIG. 35.

To show the cutaneous tenderness in Case No. 42.
The shaded area on the left side represents the 11th dorsal; that on the right side the 10th and 11th dorsal.

Case 42.—Eliz. B., widow. U.C.H. (Dr. Spencer), July, 1891.
In January, 1891, an attempt was made to remove both ovaries and both tubes for tubo-ovarian hæmatocele. The left ovary and greater part of the left tube were removed whereas a portion of the right ovary was left behind.

The uterus is movable, retroverted, and tilted a little to the right side. Right stump can be felt as big as tip of forefinger. On making pressure high up on the right side a tender body can be touched. Cervix rather small.

Strong, healthy looking woman, well nourished, bright, cheerful and not emotional. She complains of occasional pain, worse on right side than left in lower part of abdomen and back. Cutaneous tenderness well marked as in fig. 2.

Subsequently the whole of this pain and tenderness disappeared and she is now bright and well.

It is well known that after the removal of an ovarian tumour the patient complains of pain in the back over the region of the loin for which morphia is frequently given. It is customary to place a small pillow under the loin to ease this pain. In a case in which a tubal fœtation was removed by operation the tube and broad ligament were much

injured and the nurse called my attention to the fact that the pain was not in the usual place but lower down than usual over the upper part of the sacrum. I made the same observation in a case where a cyst had been removed from the broad ligament. Both these cases had borne children and described the pain as like a "dull labour pain." I subsequently asked several patients from whom true ovarian tumours had been removed whether their pain resembled labour pain and got a distinctly negative answer.

Thus the Fallopian tubes, like the epididymis seem to be particularly associated with the 11th and 12th dorsal segments.

Cervix and Os Uteri.

It is a well recognised fact that erosions and early malignant disease of the vaginal surface of the cervix produce no pain. But directly they set up cervical catarrh or begin

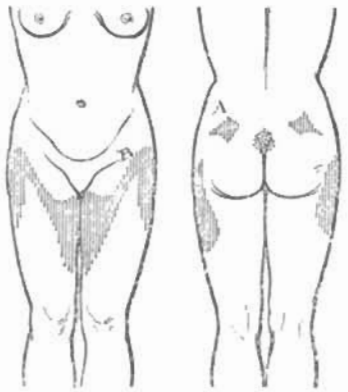


FIG. 36

To show the cutaneous tenderness produced by the passage of a probe in a case of cervical catarrh (Case No. 43).
The shaded areas marked A and B represent the 1st lumbar. The small dotted area over the sacrum represents the maximum of the 4th sacral.

to invade the broad ligaments pain begins. Such a disease was therefore too wide reaching in its effects for my purpose.

I made several interesting observations during the copper sulphate treatment, in cases of cervical catarrh. The effects

produced by the passage of the Playfair's probe were very instructive. As the probe enters the external os the patient complains of no discomfort. As it ascends the canal she begins to complain of a pain over the lower sacral region. As the probe advances still further the pain alters in position and is situated over the last lumbar and first sacral spines and in the groin in front. One of my patients repeatedly said :—" I first have pain at the very bottom of my back shooting through my legs and then as you push it further in I get a pain in my groin." The treatment was not in any sense of the word truly painful but it was frequently followed by some cutaneous tenderness in cases of cervical catarrh. (*Vide* fig. 36.)

Case 43.—Ellen T., aged 21, one child. U. C. H. (Dr. Williams), October, 1891.

Bright, well nourished, healthy looking woman.

Uterus, normal size. Slightly retroverted and retroflexed, but freely moveable. Right ovary can just be touched; not tender. Erosion on cervix. A good deal of clear mucus from cervical canal.

The erosion and cervical catarrh rapidly improved under the copper-sulphate treatment, and rest in bed.

October 22. Dressing the cervix was followed by cutaneous tenderness over the areas in fig. 36. She is now nearly well.

November 26. Free from pain and tenderness. Erosion healed. No discharge from cervix. Has passed through a menstrual period without pain. Has been at work for a week, and is bright and well.

In those cases where the canal is widely lacerated by previous labours, the lower (sacral) pain seems to be absent. In a case where a mucous polypus was very high up, not extending through the external os, the pain, accompanied by marked cutaneous tenderness, was situated over the area on the skin corresponding to the eleventh dorsal area together with the maxima of the twelfth dorsal.

This opens up the whole interesting question of dysmenorrhœa and its treatment, which I shall touch upon shortly later in this paper. (*Vide* p. 106.)

Thus the lower portion of the cervical canal seems to be associated with the 3rd and 4th sacral areas, whilst the upper portion in the region of the internal os is related to the areas of the 11th and 12th dorsal segments.

Pains during and after Labour.

During the first two stages of labour, pain appears over two separate points. The so-called " niggling pains " cause pain over the upper part of the sacrum and in the groins, whilst a pain appears later over the extreme lower part of the back in the region of the sacrum and coccyx.

The following case in which I induced labour at seven and a half months shows this very well, and gives us the clue to the meaning of these pains. The thin bougie was introduced in the evening, and I left her free from pain.

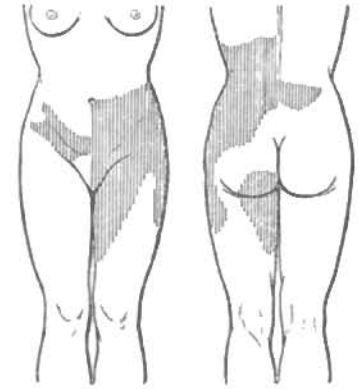


FIG. 37.

On the right half of the body on each of these figures is shown the cutaneous tenderness which appeared during the second stage of labour in Case No. 44. The area marked out represents the 11th dorsal.

On the left half of the body in each figure is shown the cutaneous tenderness which accompanied the " after pains " 48 hours after delivery in the same case. The areas represent the 10th, 11th, 12th dorsal and 1st lumbar, and the 3rd sacral at the back of the thigh.

Next morning, pain had come on over the last lumbar and upper sacral spines, shooting round the crest of the ilium on both sides to the lower part of the abdomen. Towards evening these pains were joined by pain over the lower part of the sacrum and coccyx, " shooting through the privates " to the mons veneris in front. I made a note at the time, " os dilating well," and I found that manual dilatation of the os caused increase of pain over the lower sacral area. By

the night, these lower pains had got the upper hand, and practically all the pain was situated over the lower part of the sacrum and coccyx and in the perineum.

"After pains" are caused by the uterus expelling clots, &c., that have been left behind at the time of labour; for they seldom occur if the uterus is well and carefully kneaded after the expulsion of the placenta. The pains are increased at the time by the administration of ergot. They are rythmical, coming on and passing off again, and each is mostly accompanied by the passage of a clot. They are frequently accompanied by considerable tenderness which is cutaneous and follows the areas laid down in this paper.

Case 44.—Mrs. L. U. C. H., Midwifery Department.

Second stage of labour. Membranes ruptured. Os dilated. Child presenting by vertex.

Pains round the body "like a hoop." Only in the groin and back. Very marked cutaneous tenderness as in fig. 37 (right half of each diagram). After delivery the pain and tenderness began to extend down the outer side of the thigh, and almost to the knee on the inner side of thigh.

Confined 48 hours. Complains of bad after pains. Marked cutaneous tenderness as in fig. 37 (left half of each diagram).

Third day after delivery all pain gone. Slight cutaneous tenderness still remains.

Recovered as usual, and was up on the tenth day.

Fig. 37 shows the cutaneous tenderness associated with the pain of the second stage of labour on the right side, and the tenderness found forty-eight hours after labour in association with "after pains" in the same woman. It will be seen that the pain of labour is associated with tenderness over the eleventh dorsal, and the "after pains" with tenderness over the tenth, eleventh and twelfth dorsal, first lumbar, and third sacral areas.

In multiparæ, the os is frequently extensively lacerated by previous labours so that the cervical canal practically does not exist. In such cases the lower or sacral areas of pain do not seem to appear after labour. In the case of a woman whose os was deeply lacerated by the birth of a large child the year before, "after pains" associated with cutaneous tenderness only appeared over the areas corresponding to the tenth, eleventh, and twelfth dorsal areas. There was no sign of reference to the sacral areas on the back of the thigh. She said that at all her labours before she was obliged to have someone to "rub her back" (over

the lower part of the sacrum), but this time "she did not know herself," for she had no pain over any part of the back excepting where she "now has them."

It might perhaps be objected, that the few instances I have given of tenderness in the skin associated with after pains were open to doubt in that women were notoriously "hysterical." I think this objection is set aside by the fact, that out of 178 women whom I visited within 48 hours of labour, 52 had such well marked cutaneous tenderness, that I could map it out on a chart. Thus, in my experience of hospital patients delivered by students, 30 per cent. showed some cutaneous tenderness within the first 48 hours after labour. Moreover, my impression is that this tenderness is always worst in those cases in which the child was born before the arrival of the doctor, and in those cases in which the student was inexperienced (at the beginning of the month of duty), showing the relation of the pain and tenderness to incomplete evacuation of the uterus.

Thus the uterus like the bladder causes referred pain and cutaneous tenderness over a double set of areas. Anything which stretches the lower segment and especially the cervical canal proper causes pain and tenderness over the fourth, third and sometimes the second, and even first sacral areas.

On the other hand painful contractions of the uterus are accompanied by pain over the eleventh, twelfth and sometimes the tenth dorsal areas, together with occasionally the area of the first lumbar segment.

Pleura and Peritoneum.

Referred pain such as we have considered in this chapter is characterised by the following features.

1st. It tends to follow the lines of spinal segmentation rather than those of peripheral nerves. Thus on the chest it cuts across several ribs and does not follow the lines of any one intercostal space.

2nd. It tends to form bands round the body and thus in diseases of the abdominal viscera the pain may be quite as marked in the back as over the abdomen.

3rd. It is mostly associated with cutaneous tenderness, which may be quite as marked at a distance from the affected organ as in its neighbourhood. Thus gall stones are not only associated with tenderness over the area of the gall bladder in front, but also with tenderness over the ribs and spine behind. In the same way intestinal disorders may cause a band of tenderness extending round the body, not only in the loin but also overlapping the summit of the iliac crest on its way to the front.

Now I was long ago struck by the fact that in affections of the peritoneum the pain and tenderness differed fundamentally from that of referred pain, in that, although the pain is well localised, it does not follow the line of the nerve areas. Thus, for instance the patient will refer the pain to an area both above and below the umbilicus without at the same time complaining of any pain in the back or loin.

Moreover, there is no true cutaneous tenderness in peritonitis, and the tenderness that is present differs fundamentally in character from that which accompanies referred pain. If the skin only is picked up between the finger and thumb in a case of acute peritonitis the patient complains of no pain, but directly the deeper structures of the abdominal wall are included in the gentle pressure he complains of intense pain. Thus firm steady pressure as a rule relieves referred abdominal tenderness, whilst light pressure between the finger and thumb, or even the pressure of the clothes, at once elicits it. On the other hand in peritonitis light cutaneous stimulation causes no pain, but the slighest attempt at deep pressure, or even the lightest percussion, at once causes marked pain.

Again, the distribution of the two forms of tenderness differ fundamentally. The tenderness of peritonitis may be present all over the abdomen from the ensiform cartilage to the pubes and from one costal margin to the other, but it never appears at the angle of the scapula or over the sacrum and iliac crest. On the other hand, if referred tenderness extended over the area just mentioned, spots of tenderness would appear to a certainty over the ribs in the line of the

angle of the scapula, over the costal margin in the eighth and ninth spaces, over the twelfth dorsal spine, over the twelfth rib, and over the last lumbar and first sacral spines. Thus the tenderness of peritonitis only makes its appearance over those points where pressure, &c., can actually affect the peritoneum, whilst referred abdominal tenderness is always present over bony points, where pressure cannot possibly produce any effect on the abdominal cavity or its contents.

Thirdly, we find that however great may be the pain caused by the peritonitis, the abdominal reflexes are not exaggerated as would have been the case if the tenderness had been cutaneous.

Case 45.—Amelia T., aged 42, married. U. C. H. (Mr. Beck). Was admitted November 27, for obstruction of the bowels.

Has never had any obstruction before, but for fourteen years has suffered from chronic constipation. Bowels open twice a week with medicine only.

November 20. Bowels last opened.

November 21. Sudden pain in lower part of abdomen, chiefly on the left side.

November 22. Went to work feeling ill.

November 24. Took medicine after which she vomited.

November 27. Admitted. Has not passed flatus or had desire to pass a motion since November 20. Had not vomited except after the purgative. Abdomen soft, but distended rather more on left than right side. Whole abdomen tympanitic to percussion.

Now it was a very striking feature, that although there was very marked tenderness of the left iliac fossa on even the lightest percussion or palpation all cutaneous tenderness was completely absent. There was no pain or tenderness in the back or loin, and the most posterior limit of the tenderness was a line from the tip of the eleventh rib to the crest of the ileum. Thus all tenderness was deep, and it was only present over those points where the peritoneal cavity could be disturbed by the manipulation.

It was thought to be a case of volvulus of the sigmoid flexure of the colon, and Mr. Beck operated at once. The colon and gut looked healthy, but patches of lymph could be seen on the coils of small intestine, and on separating these a little thin pus escaped. On portions of the small intestine were well defined patches of lymph, and it was evident that these coils had formed the lining wall of an abscess cavity. This abscess reached down into the pelvis and was found to be connected with the left Fallopian tube. Vermiform appendix was normal.

Abscess cavity was drained and the woman did well.

I now give a case of peritonitis in connection with perforation of the vermiform appendix to illustrate the same point.

Case 46.—Mary Ann B., aged 49, married. U.C.H. (Mr. Barker), Dec. 5.

November 26. Pain in abdomen began, but she did not stop work. December 3. Became so severe she went to bed. Pills caused action of bowels.

She has long suffered from chronic constipation.

December 5. Admitted. Well nourished. Tongue furred. No vomiting. Pain after taking solid food. Abdomen not much distended. Nothing definite in either iliac fossa. No difficulty or pain on micturition. Nothing definite felt per vaginam.

Great tenderness and pain in the abdomen. The pain is situated in the right iliac fossa, and the tenderness extends from the upper part of the fossa to the costal margin above. It does not extend over the middle line or further back than a line joining the tip of the eleventh rib and the crest of the ileum. There is no pain or tenderness in the loin. The most marked feature is the complete absence of cutaneous tenderness. Thus the skin can be picked up between the fingers without giving her any pain, but palpation or light percussion cause considerable pain. Abdominal reflex not obtained.

December 10. She began to vomit. Mr. Barker operated and found a small abscess in connection with the vermiform appendix.

The appendix was perforated, but was not swollen, and except for the perforation was healthy.

December 16. Died. *Post-mortem.*—No general peritonitis Abscess cavity shut in by firm adhesions, lower end of abscess just below brim of pelvis.

In contradistinction to these two cases I give two cases of strangulated hernia in which cutaneous tenderness over the tenth dorsal area was very marked. Both cases showed well the tenderness in the loin which is present when the whole bandlike area of the tenth dorsal is present. The second case developed peritonitis after enterectomy, and yet tenderness did not re-appear after the operation.

Case 47.—Hortense D., aged 68, married. U.C.H. (Mr. Beck).

For six months has noticed a small lump in right groin.

January 6. In the morning noticed that the lump was larger than usual, and was painful. Enema, which she thinks brought away fœcal matter.

January 7. Vomited six or eight times. Admitted at noon.

Abdomen distended. Walls thin. In right groin slightly oval swelling, size of pigeon's egg. Obviously a femoral hernia.

There is no deep tenderness, but definite cutaneous tenderness marking out fairly the area of the tenth dorsal segment on the right side. Abdominal reflex on right side a little brisker than on the left side.

The usual operation was performed and patient did well.

Case 48.—Elizabeth W., aged 30. U.C.H. (Mr. Barker).

Six months ago first noticed a swelling in the right groin, which disappeared with rest.

Six weeks ago rupture came down again, but went back under rest.

December 22. Rupture came down again.

December 23. Began to vomit. Bowels opened naturally this morning for the last time.

December 24. Worse. Vomiting continued.

December 27. Vomited last at 6 a.m. Admitted to U. C. H. General condition on admission very satisfactory. Obvious femoral hernia in right groin. Abdomen not distended. No tenderness on percussion or palpation. Very definite cutaneous tenderness on taking up the skin of the abdomen between the fingers. This cutaneous tenderness marked out very beautifully the tenth dorsal area on the right side, and was so definite, that it could be demonstrated several times in succession to onlookers. There was no cutaneous tenderness over the hernia itself. Thus all the tenderness was at a distance from the affected part. The superficial reflexes over the tender area were distinctly exaggerated and the head of a pin felt like a point.

She refers her pain to a point just to the right, and a little below the umbilicus (*i.e.*, the maximum of the tenth dorsal area in front). She also has some pain in the loin and back.

Mr. Barker operated, and found that the knuckle of gut in the hernia had ruptured in two places, allowing a small quantity of fœcal matter to escape. He excised a portion of gut, and sutured the two ends.

December 31. She passed flatus freely, and her bowels were opened. Seemed to be doing well.

January 4. Complained of pain in the wound and right hypochondrium, but there was no cutaneous tenderness.

Temperature began to run up for the first time, and she died in the night.

Post-mortem.—The juncture of the two ends of gut had leaked and there was general peritonitis.

Now an exactly similar law holds good for the pleura. Every physician is familiar with the numerous cases of "pain in the side" increased by breathing and coughing which are unaccompanied by the physical signs of pleurisy. Such pain is mostly associated with cutaneous tenderness and is in reality referred. In order to render clear the

difference between the pain of pleurisy and this referred pain let us consider the following example.

A man of 36 complained of cough accompanied by intense pain over an area the size of the palm of the hand situated over the sixth, seventh and eighth ribs. It extended from the level of the posterior axillary fold forwards nearly to the costal margin on the left side. There was no tenderness when the skin was lightly picked up between the finger and thumb but the most exquisite tenderness on the lighter percussion or pressure with the fingers. There was no tenderness in the abdomen or in the line of the angle of the scapula and over the vertebral spines. Over this painful area very marked pleural friction was audible. Now if this pain and tenderness had been referred it would have corresponded to the maximum of the eighth dorsal area. But with such exquisite pain the posterior and also the abdominal portion of this area must have been affected, and true cutaneous tenderness would have certainly manifested itself. I have more than once had the opportunity of seeing true referred pain accompanied by cutaneous tenderness on the one side associated with the local pains and deep tenderness of pleurisy on the other.

Another feature of the pain of pleurisy which I wish to emphasize is its conduction along the line of the intercostal nerves as opposed to those of the segmental areas. Thus a pleuritic pain situated in the ninth and tenth space in the line of the angle of the scapula will radiate forwards along these inter-spaces to about the umbilicus. From before backwards it will cut across the lines of the seventh, eighth and ninth segmental areas and will finally enter the distribution of the tenth dorsal segment. Although it radiates on to the abdomen all tenderness ceases as soon as the costal border is passed.

Case, 49.—James P., aged 56. U. C. H. (Dr. Roberts), 1892.

Was at work and appeared healthy until two weeks before admission, when he developed a bad cough. The day before admission he coughed up blood, and when admitted, was still bringing up very highly blood-stained sputum.

Constant hard cough. Cough caused pain over an area the size of the palm of the hand, situated over the sixth, seventh, and eighth ribs. It extended from the level of the posterior axillary fold forwards nearly to the costal margin. There was no superficial or cutaneous tenderness, but even light percussion or pressure with the fingers caused pain. No tenderness in the abdomen in front of the costal margin or at the angle of the scapula, and over the vertebral spines.

Left base moves less than right. Over left base in the axillary line from the fifth rib downwards, very marked pleural friction. Slight signs of consolidation at left apex and base.

This pain was removed by strapping the left side.

Thus in conclusion I think we can formulate the following statement. Affections of the serous cavities of the body do not cause referred pain or cutaneous tenderness, but produce local pain which follows the lines of peripheral nerves and is associated with deep tenderness over the affected point only.

CHAPTER IV.

THE SENSORY FIBRES IN THE SYMPATHETIC SYSTEM.

I have gone through all the organs systematically in the last chapter and attempted to show that the pain and tenderness caused by certain disturbances in their normal activity is referred along the distribution of certain somatic nerves. Now on Ross's[1] hypothesis a knowledge of the nerve roots along which reference takes place enables us to map out the sensory supply which the affected organs receive by means of the sympathetic. For on this hypothesis the viscera receive their sensory fibres from that segment of the spinal cord from which the somatic sensory roots arise along which the pain is referred.

I will therefore put together the results arrived at in the previous chapter in the form of a table. But I must first call attention again to the fact that certain organs have a tendency to refer into the supply of the cervical plexus and that of the cranial nerves. The organs in which this feature is more marked are the lungs, heart, liver, intestines, and stomach. I cannot now enter into a full discussion of the significance of this fact, but must reserve it for my next

[1] BRAIN, January, 1888.

communication in which I hope to describe the areas of referred pain and tenderness for the head and neck. I must however, for the purpose of this table state that I consider this reference to the head and neck to represent the supply of the vagus and depressor, and thus in all those cases where the disturbance of an organ produces direct reference above the clavicles I have inserted these nerves in my tabular statement of the segments from which they are supplied.

Heart.—1st, 2nd, 3rd, dorsal segments.
Cervical plexus [= depressor?]

Lungs.—1st, 2nd, 3rd, 4th, 5th dorsal.
Cervical plexus [= vagus?]

Stomach.—6th, 7th, 8th, 9th dorsal.
Cardiac end from 6th and 7th.
Pyloric end from 9th.

Intestines.—[A.] Down to upper part of rectum.
9th, 10th, 11th and 12th dorsal.

[B.] Rectum.
2nd, 3rd and 4th sacral.

Liver and *Gall Bladder.*—7th, 8th, 9th, 10th dorsal.
Perhaps 6th dorsal.
Cervical plexus [= vagus?]

Kidney and *Ureter.*—10th, 11th and 12th. The nearer the lesion lies to the kidney the more is the pain and tenderness associated with the 10th dorsal. The lower the lesion in the ureter the more does the 1st lumbar tend to appear.

Bladder.—[A.] Mucous membrane and neck of bladder.
[1st.] 2nd, 3rd, 4th sacral.

[B.] Over-distension and ineffectual contraction.
11th and 12th dorsal and 1st lumbar.

Prostate.—10th, 11th, [12th] dorsal.
1st, 2nd, 3rd sacral and 5th lumbar.

Epididymis.—11th and 12th dorsal and 1st lumbar.

Testis.—10th dorsal.

Ovary.—10th dorsal.

Appendages, &c.—11th and 12th dorsal and 1st lumbar.

Uterus.—[A.] In contraction,
10th, 11th, 12th dorsal and 1st lumbar.

[B.] Os uteri,
[1st], 2nd, 3rd, 4th sacral [and 5th lumbar very rarely].

It is obvious from this table that the sensory supply of the viscera bears a very curious resemblance to Gaskell's[1] scheme of their motor and inhibitory supply. I was therefore exceedingly interested to hear from Dr. Gaskell that my supply closely represented the results obtained by Edgeworth by anatomical methods. Edgeworth's paper in the May number of the *Journal of Physiology* showed how closely we were agreed and yet how different were our results on certain points. Firstly as to the differences, which I do not think are essential. Edgeworth dissected and examined microscopically the sympathetic branches in the dog. Now this animal possesses thirteen dorsal and seven lumbar roots. Edgeworth finds that the large medullated fibres which he believes to be the sensory fibres of the viscera come off from the first dorsal to the third lumbar roots inclusive. There is then a blank of three roots from which no such fibres come off followed by another outburst of these fibres from the region of the seventh lumbar and first and second sacral. Now in man there are but twelve dorsal and five lumbar vertebræ and I find that my method gives a supply of visceral sensory fibres from the first dorsal to the first lumbar segments with perhaps also very rarely the second lumbar. Then follows a blank of three roots followed by a lumbo-sacral outburst from the fifth lumbar and first, second, third and fourth sacral. Of these the fifth lumbar is only occasionally seen. Now I think that considering the different anatomical construction of man and the dog these differences are but of slight importance. And now to pass on to the points upon which we arrived at similar results. Edgeworth finds that the heart, lungs, stomach, liver, and intestines

[1] *Journal of Physiology*, vol. vii., 1885.

are all supplied by large fibres from above which reach them in the vagus, and in the case of the heart by the depressor nerve. Now these are the organs which I believe give reference into the areas above the clavicle, *i.e.*, into the region of the head and neck above the upper gap. The most definite reference into the neck is given by the liver, lungs, and heart.

Another point on which we are united as will be seen by comparing my table with Edgeworth's chart is in the double supply of the bladder. The double supply of the prostate and uterus he does not seem to mention. Thus I think that the results produced by both the anatomical (Edgeworth) and by the physiological methods tend to show that the sensory distribution of the sympathetic essentially follows the lines laid down by Gaskell for the course of its motor and inhibitory fibres.

Before I leave this subject I should like to mention some interesting points brought out by the recognition of the double supply of the bladder. In those cases where the distribution of the analgesia points to a lesion of the sacral region of the spinal cord the patient says he knows when he wants to pass water but he has no power of retaining it. As soon as a few ounces have collected in his bladder he "feels he wants to pass it and cannot hold it back." It then comes from him involuntarily. A patient in this condition has analgesia over the areas corresponding to the third and fourth sacral segments.

If, on the other hand, the analgesia is over an area corresponding to the eleventh and twelfth dorsal and first lumbar areas, and sensation is normal over the sacral area, the condition of the bladder is exactly the reverse. The patient is quite unconscious of the desire to pass water, and the bladder will gradually fill until it contains 40 to 60 ounces of fluid. If a catheter is not passed the urine will gradually accumulate until it begins to dribble past the sphincter from mechanical pressure, and the condition known as "dribbling from overflow" will have been established.

If, however, the distribution of the analgesia points to a local lesion above the ninth dorsal segment, a third condition

of the bladder will appear. The urine will collect in the bladder until it has reached 15 to 20 ounces, and then will be passed without the patient's knowledge. Thus here the passage of urine is a normal but completely automatic act.

In the first class of cases the bed is always wet; in the second class the bed is never wetted if a catheter is passed about three times in the twenty-four hours; in the third class the bed is wetted three or four times only in the twenty-four hours, and is then saturated with a large quantity of urine.

Throughout the study of cases of nervous disease, evidence of the relation between pathological condition of certain viscera and sensory disturbances in the superficial structures of the body is constantly manifested. For instance, a man with caries of the spine suffered from a girdle sensation round the area of the eighth dorsal segment. At the same time he was greatly troubled by flatulent dyspepsia, which was untouched by drugs. It was, however, greatly relieved by counter irritation applied to the maximum tender point of the eighth dorsal area in the eighth space and mid axillary line.

Again in a case of tabes with analgesia over the area supplied by the tenth dorsal root, I saw an attack of complete paralysis of the small intestines simulating intestinal obstruction.

Thus, in conclusion, I feel inclined to think that the sensory supply of the viscera agrees with Dr. Gaskell's scheme for their motor and inhibitory supply in the following points:—

[1st]. The sensory fibres enter the central nervous system in three great groups. The highest of these is in the head and neck, the middle group lies beween the 1st dorsal and 1st lumbar segments of the spinal cord; the lowest group extends from the 5th lumbar to the 4th sacral segments.

[2nd]. Thus there are two gaps in the spinal cord which are not in connection with sensory fibres from the viscera. The higher of these consists of the 5th, 6th, 7th and 8th cervical segments, whilst the lower corresponds to the 2nd, 3rd and 4th lumbar segments.

dim. Finally, she only reads J 10 badly. This occurs with each eye.

Marked diminution in the field of vision for white and black and to a still greater extent for colours.

No nystagmus. Cranial nerves normal, excepting that the sensation of the pharynx seems to be abolished.

Sphincters normal.

Circulatory and respiratory systems are normal.

Appetite poor, tongue clean. No enema was administered during her stay in the hospital, but she was told that her bowels would act normally. They acted regularly every day without artificial aid of any kind.

August 27. Feels the wire brush, and cries with the pain.

August 29. All forms of sensation now good. They returned simultaneously.

August 30. Can only bear wire brush at half the full strength.

September 1. Moves legs to command, though slowly.

September 8. Pharyngeal reflex has returned.

December 7. She left the hospital cured, excepting for occasional pain in the back.

These three cases exemplify the difference between the two types of so-called hysteria. For Case No. 54 was characterised by the following points :—

(1) The loss of sensation followed the lines laid down in this paper for the distribution of sensory disturbances in visceral disease.

(2) Reflexes were abolished over the anæsthetic area.

(3) There was no limitation of the field of vision.

On the other hand Cases No. 55 and No. 56 agreed in the following points :—

(1) The loss of sensation followed lines incompatible with the areas affected in visceral disease.

(2) The plantar reflexes in Case No. 56 and the cremasteric and gluteal reflexes in Case No. 55 were present over the anæsthetic area.

(3) There was marked diminution in the visual field.

Now we can see how it is possible for the cerebro-spinal type to become associated with organic disease. The question at present agitating neurologists is the relation of disseminated sclerosis to "functional" disease. An enormous number of cases of disseminated sclerosis with tremor nystagmus and optic atrophy, have been preceded by years of undoubted "hysterical" manifestations—alteration in sensibility, vomiting, double sciatica, &c. Moreover, many of them have in this "hysterical" stage been "cured" more than once.

Thus I should like to suggest that the term "hysterical" be kept for the psychical type only, whilst the term "functional" disease be made to include all forms of generalised pain or loss of sensation following definite cerebro-spinal lines, whether the alteration in the nervous system is caused by anæmia, pyrexia, menstruation, &c., or some truly nervous influence, such as shock, or long continued visceral pain.

CHAPTER VI.

THEORETICAL.

§ 1. Why is pain referred?
§ 2. Why is the skin tender in visceral disease?
§ 3. The central relations of the various forms of sensation.

§ 1. *Why is pain referred?*

This constant reference of pain to the skin when the lesion affects an internal organ at first sight seems inexplicable. But I think a consideration of the following facts brings us a little nearer the comprehension of its significance and of the method in which it originally came about.

If I prick my foot I do not feel pain anywhere except in the foot itself about the point pricked. If the various parts of the body are tested it is found that our powers of localisation for a painful stimulus are very fairly accurate even over such comparatively insensitive parts as the back. If however the power of perceiving pain is diminished over a certain area on my foot, as occurs so frequently in such diseases as tabes dorsalis, the pain is no longer localised to the point pricked but is referred higher up the leg or if the sensation of the opposite foot is good to the corresponding point on the opposite foot. This is a phenomenon known as allocheiria. This is still better shown in cases of nervous disease where the patient has lost the sense of pain, to a considerable extent, over the areas of both sides of the abdomen corresponding to the distribution of the tenth and eleventh dorsal segments. If such a patient is pricked at a point about 2 inches below the umbilicus he will feel the pain but will refer it to a point about a similar distance

above the umbilicus. A second prick one inch below the umbilicus is referred to a point about the same distance above. A third prick almost on the border line which separates the area of diminished sensation from the area over which sensation is normal will be referred to a point just on the healthy side of the line. Thus, although the actual stimuli have been ascending towards the umbilical line, the patient says that he has experienced a series of pricks descending towards the umbilicus. If he is now pricked three times on the healthy skin over the spots to which he originally referred his pain, he will say that the pricks are ascending. Thus six painful stimuli applied over the abdomen, beginning at a point about 2 inches below the umbilicus in the area of diminished sensation and ending two inches above the unbilicus in the area of healthy sensation, will be said to be three pricks descending towards the umbilical line followed by three over the same spots ascending from the umbilicus.

This rule applies to all forms of sensation. If the sensation of touch is affected, but pain and heat and cold are normal, touch only will be referred, whilst heat, cold and pain are rightly localised. In the same way if heat or cold only are affected whilst pain and touch are normal, heat or cold stimuli will be referred, whilst pain and touch are rightly localised. I have records of cases in which only one form of the four sensations was wrongly localised, whilst the others were localised over the point of stimulation.

In all such cases of wrong localisation the particular sensation which is wrongly localised must be diminished, and must not be absolutely lost over the affected area. If the power of perceiving this stimulus is totally lost the stimulus is simply not perceived and there is no allocheiria.

Now the localisation of sensation is not a physical but a psychical phenomenon. It is not a question of the number of rods and cones or of the number of nerve end organs, but is a phenomenon of association. Thus supposing a prick was so applied that it just stimulated one nerve end organ, this stimulus so caused would pass up one fibre and probably remain distinct all up the cord. But in consciousness the

final result of this stimulus appears as a disturbance in the psychical field over a wide area with its maximum at one point representing the psychical unit which corresponded to the part stimulated. The disturbance over this point is, however, so greatly in excess of that over any portion of the diffusion field, that the diffusion field goes under the threshold and the position of the stimulus is rightly localised. If, however, the presentation to consciousness, which is the psychical equivalent of the point of stimulation, is less powerful than usual, owing to the physiological diminution produced by the partial analgesia of the area stimulated, the diffusion field will no longer be driven under the threshold. Thus the psychical effect produced by the area of diffusion may be even in excess of that representing the point of stimulation, and the latter will now go under the threshold. Under such conditions the position of the stimulation will no longer be localised at the point stimulated, but somewhere in the area of diffusion.

Now whenever an area representing one or more spinal segments on one side of the body is partially anæsthetic, whilst the sensation of the areas representing the same segments on the other side is normal, a stimulus to the skin over the affected areas is referred to the corresponding point on the normal side. If, however, the segments on both sides are affected, the stimulus is referred to the area corresponding to the area next above or next below the affected segments in their origin from the cord. Thus supposing the first, second and third lumbar areas are partly analgesic, a prick over their distribution will be referred to the area supplied by the twelfth dorsal or fourth and fifth lumbar. Now, as can be seen from plates I. and II., the posterior limits of these three areas closely abut on the limits of the second, third and fourth sacral roots on the outer and posterior aspects of the thigh. And yet a prick near the posterior border of these lumbar areas is not referred a few inches further back on to the distribution of the sacral areas, but to some point in the groin or below the knee (twelfth dorsal or fourth and fifth lumbar), more than 12 inches distant. This statement appears to be

true for pain, heat and cold, which do not overlap, but is I believe not true for touch, for the distribution of the touch areas overlaps considerably.

These facts have an obvious bearing on the reference of the pain produced by visceral disease. For the viscera are notoriously insensitive to touch and to the stimulus of a cut with a knife. Thus after gastrotomy the mucous membrane of the stomach can be tickled with a feather, or gently pinched with the forceps without the patient's knowledge. In liver operations it is customary to stitch the liver to the abdominal wall, as a preliminary to opening the organ when adhesions have formed. If the second stage of the operation is done without an anæsthetic the patient is quite unable to say when the knife is plunged into his liver, and after the whole is over and the drainage tube in place, will ask "when the operation is going to begin." The same statement applies to the second stage of an inguinal colotomy, in which the gut is opened by a clean cut of the knife. The only stimuli which seem to act on the viscera are tearing or rending in character, in fact pressure stimuli.

Thus, as our viscera are so notoriously insensitive, and as we have never had the opportunity of developing the sense of localisation in them, owing to their inaccesibility to touch, it is not to be wondered at that the maximum pain is not felt in the organ affected. They are thus as regards the localisation of sensation in exactly the position of the area on the skin whose sensation of pain was diminished in comparison with that of its neighbours. A painful stimulus to an internal organ is conducted to that segment of the cord from which its sensory nerves are given off. There it comes into close connection with the fibres for painful sensation from the surface of the body which also arose from the same segment. But the sensory and localising power of the surface of the body is enormously in excess of that of the viscera, and thus by what might be called a psychical error of judgment the diffusion area is accepted by consciousness, and the pain is referred on to the surface of the body instead of on to the organ actually affected. I do not mean to state that pain is never referred to the organ affected. Far from

it. The pain is frequently felt in the organ itself, but it is "dull," "heavy," "wearing," and not "sharp," "aching," "stabbing," like the referred pain.

Thus I believe that the phenomena of allocheiria and of referred pain in visceral disease are in nature and explanation essentially the same. Both depend for their appearance on the law that where a painful stimulus is applied to a part of low sensibility in close central connection with a part of much greater sensibility the pain produced is felt in the part of higher sensibility rather than in the part of lower sensibility to which the stimulus was actually applied.

§ 2. *Why is the Skin Tender in consequence of Visceral Disease?*

If impulses pass up the sensory nerves from an organ which is diseased to the cord they will set up a disturbance in the segment of the cord to which they are conducted. Now any second sensory impulse from another part conducted to the same segment of the cord will be profoundly altered. Under normal circumstances it would have set up its own proper disturbance in the grey matter and this disturbance would have been conducted to the brain. But now it no longer falls into a normal and quiescent cord but into one whose activity is already disturbed. The resultant stimulus conducted upwards is therefore a very different one from that which would have passed on under normal circumstances. In many cases the second stimulus will be exaggerated like rays passing to the eye through a convex glass. Thus if any segment of the cord is disturbed by painful stimuli from an internal organ a stimulus applied to the skin over the areas supplied by the nerve roots belonging to this segment will be exaggerated and a stimulus which normally was perhaps only uncomfortable would now appear to be very painful.

But in order that this condition may result the central connection between the sensory nerves from the viscera must be closely connected with that part of the cord into which the sensory stimuli from the skin are conducted. Now we never find cutaneous *hyperæsthesia* or increased sensitive-

ness to touch as the result of visceral pain but only increased sensitiveness to pain or *hyperalgesia*. It might be objected that we do not know of the possibility of hyperæsthesia apart from hyperalgesia but the following case illustrates the difference well.

A tabetic who is now under observation has complete loss of the sensation of pain over the thorax and abdomen. Thus he is quite unable to feel the prick of a sharp needle, and no reflex is produced by a sharp prick on the abdomen. But the slightest touch produces the most profound disturbance; an enormous reflex is produced and he says that the touch causes a feeling of the most exaggerated tickling. He complains that nothing he has ever experienced was equal to the exaggerated feeling of "ticklishness" which is produced by a light touch over the affected area. Thus the man has over the same area hyperæsthesia or exaggerated sensation of touch with analgesia or absent sensation to pain.

In the same way I have seen cases where even the mildest heat was said to "burn," though touch, pain and cold were normal; in such cases the reflex produced by the warmth was exaggerated whilst the reflexes produced by the other forms of stimulation were normal.

Now visceral pain always produces exaggeration of the sense of pain and sometimes exaggeration of the sense of heat and cold in the skin but never so far as my experience goes does it produce exaggeration of the sense of touch or hyperæsthesia proper.

§ 3. *The Central Relation of the Various Forms of Sensation.*

This leads me to another and wide-reaching question—What is the relation in the central nervous system of the various forms of sensation?

We have already seen reason to believe that the cutaneous distribution of touch overlaps considerably. On the other hand the cutaneous distribution of pain, heat and cold do not overlap appreciably. In this their distribution agrees with that of the trophic nerves to the skin from each segment

of the cord, which, as I showed by a study of the distribution of herpes zoster, are also found not to overlap.

Then again, we find that visceral disturbances may cause exaggeration of the cutaneous sensibility to pain, to heat and to cold, and are also closely related to trophic disturbances on the skin, such as herpes zoster. On the other hand they never cause exaggeration of the sensibility to touch.

Now in central gliomatosis, usually known under the name of syringomyelia, pain, heat and cold are profoundly disturbed, and there is a particular proneness to the development of cutaneous trophic lesions. On the other hand touch is either not affected at all or affected very late in the disease when the growth has produced profound pressure effects. Thus here again we find that a lesion around the central canal of the spinal cord tends to destroy the one group and to leave the other unaffected.

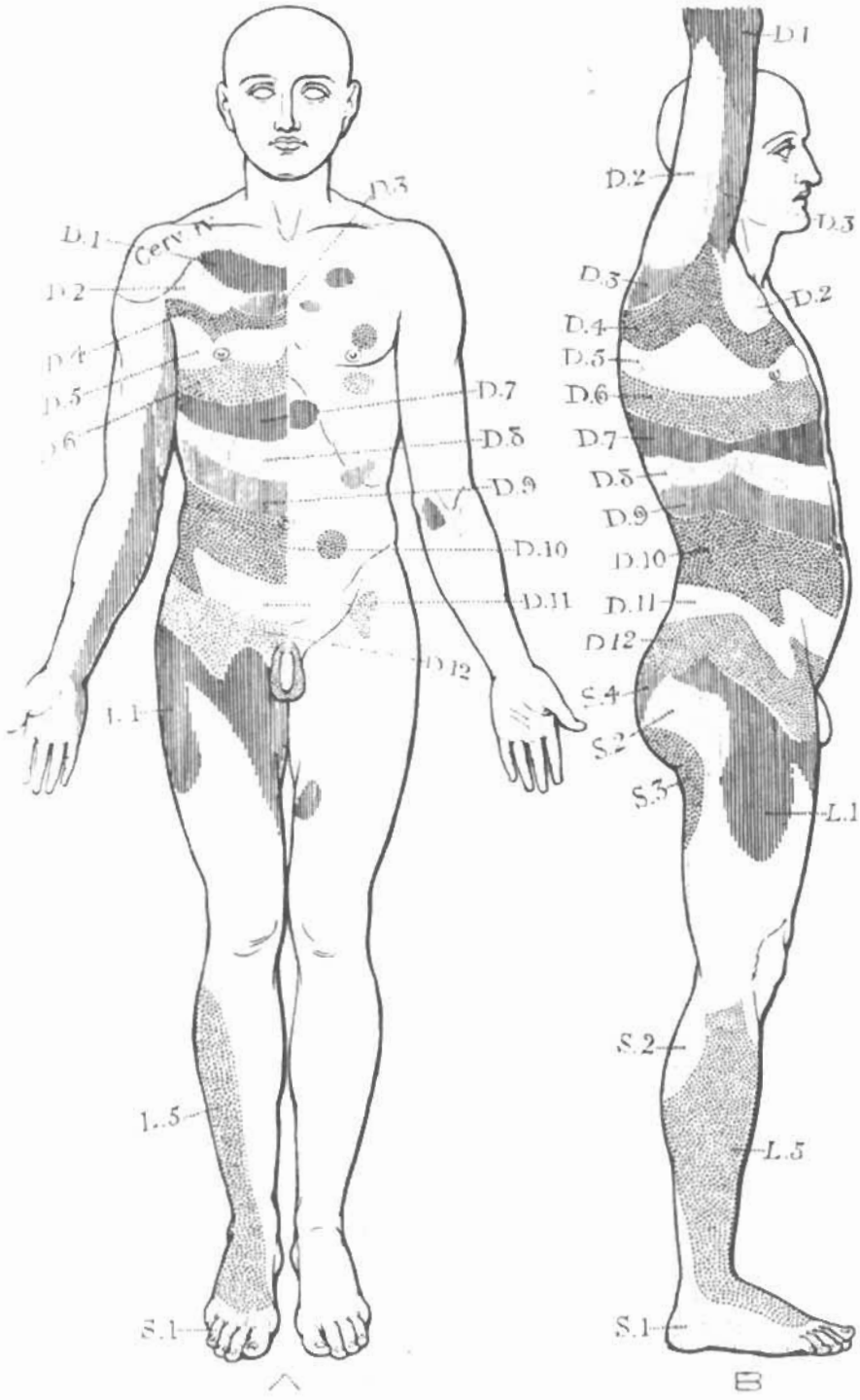
Thus I think that these facts tend to show that there is an intimate connection between the central connections for the sensory nerves of the viscera and the nerves which supply the sensation of pain, heat and cold, and also those which exert a trophic influence on the skin. I do not therefore think we shall be far wrong in assuming that the trophic nerves to the viscera bear a similar relation to the sensory sympathetic fibres as the trophic nerves to the skin bear to the fibres for pain. If this be so it will help to explain the effect produced by counter-irritation of the skin on the activity of the viscera. Conversely it will also explain the occasional improvement in pains of a purely nervous origin by some visceral irritation, *e.g.*, the removal of lightning pains over the 1st, 2nd, 3rd and 4th sacral [rectum] areas in a tabetic by the administration of a purge such as castor oil.

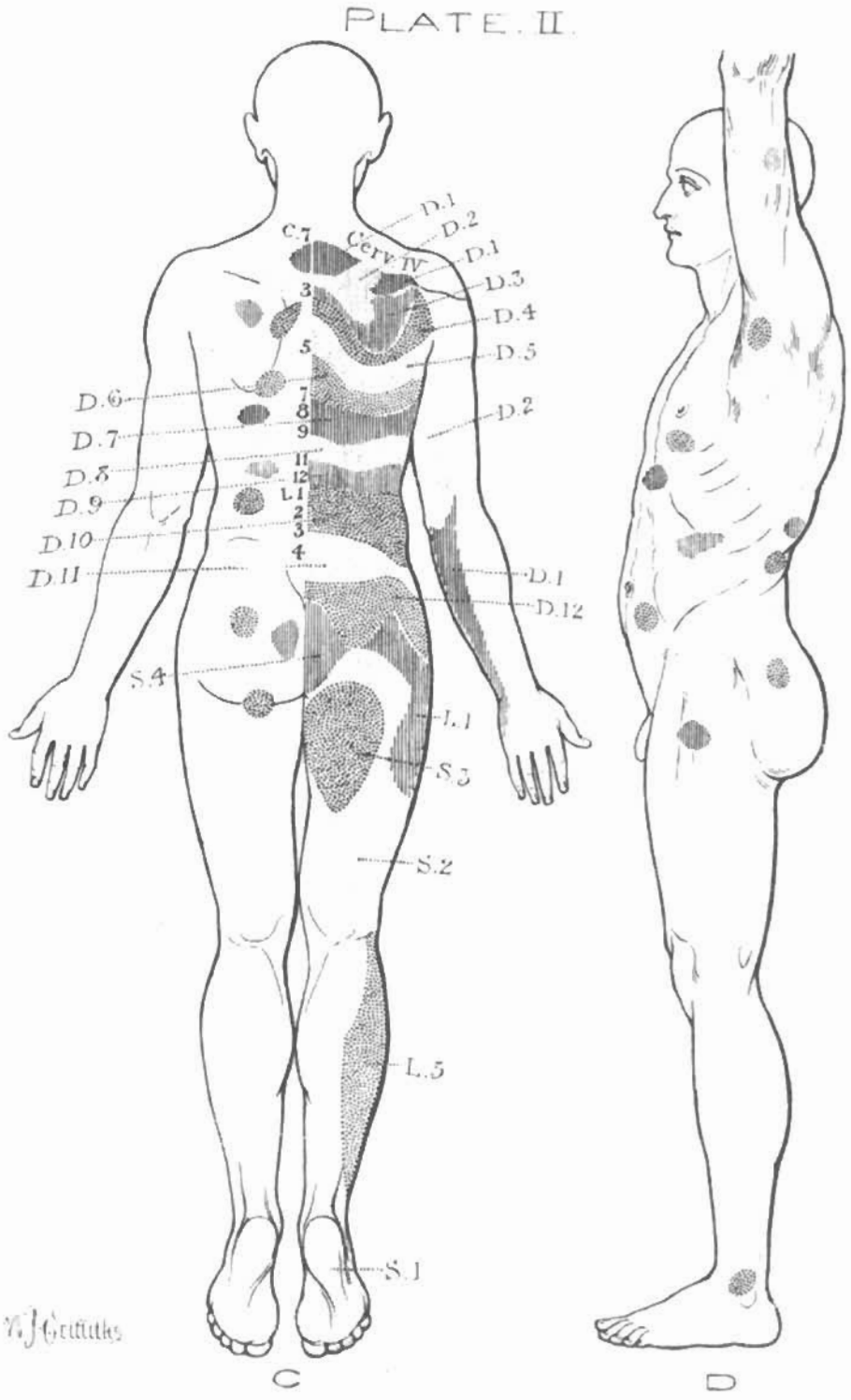
Thus to sum up I think we may conclude that the central connections of the pain fibres from the skin and viscera are closely connected with one another. The central connections of the nerves for heat and cold, and for trophic disturbances in the skin must also be in somewhat close association, though probably not actually connected. On the other hand

the nerves for touch from the skin (we do not know whether nerves for touch exist in the viscera) are widely separated centrally from those of pain. As to their paths in the cord I do not yet feel qualified to speak definitely.

It is now my pleasing duty to thank those who have been so liberal in their help during this investigation. Firstly, my best thanks are due to the physicians and surgeons of University College Hospital for the kind way they have permitted me to use their cases. I also have to return my sincere thanks to the medical and surgical staff of the National Hospital for Paralysed and Epileptic, Queen Square, and especially to Dr. Buzzard, my chief, for their generosity towards me. In each report from these two hospitals I have given the name of the physician and surgeon to whose kindness I am indebted for the case. In all cases the disturbance of sensation was worked out by myself, but in the surgical cases I am indebted to Mr. G. B. M. White, Surgical Registrar to University College Hospital, for the report of the patients' physical condition. I beg to return him my best thanks. My thanks are also due to Dr. Bowmar and Dr. Wood, House Physicians at Queen Square, and to the House Physicians and Surgeons of University College Hospital for much kind thought and help in this laborious investigation.

PLATE I.





DESCRIPTION OF PLATES I. AND II.

These plates are intended to show the distribution of the segmental areas from the 1st dorsal to the 4th sacral. The form and extent of each area here figured is deduced from:

[1st]. The appearances presented by the cutaneous tenderness in visceral disease.

[2nd]. The distribution of the eruptions in 62 cases of herpes zoster.

[3rd]. The limits of analgesia (or loss of painful sensation) in organic disease of the spinal cord and roots.

I do not suppose that the areas here figured are absolutely correct, and can but hope that future investigation will show that their situation and extent bears a fairly close relation to the truth.

Cerv. IV. represents the lower border of the area supplied by the 3rd and 4th cervical areas.

Then follows a gap which is not usually represented in the disturbances of viscera. This gap corresponds to the 5th, 6th, 7th, and 8th cervical segments, and will be filled in, in my paper on the "Head and Neck."

D. 1 represents the dorso-ulnar or 1st dorsal area.
D. 2 represents the dorso-brachial or 2nd dorsal area.
D. 3 represents the scapulo-brachial or 3rd dorsal area.
D. 4 represents the dorso-axillary or 4th dorsal area.
D. 5 represents the scapulo-axillary or 5th dorsal area.
D. 6 represents the sub-scapulo inframammary or 6th dorsal area.
D. 7 represents the sub-scapulo ensiform or 7th dorsal area.
D. 8 represents the middle epigastric or 8th dorsal area.
D. 9 represents the supra-umbilical or 9th dorsal area.
D. 10 represents the sub-umbilical or 10th dorsal area.
D. 11 represents the sacro-iliac or 11th dorsal area.
D. 12 represents the sacro-femoral or 12th dorsal area.
L. 1 represents the gluteo-crural or 1st lumbar area.

Then follows a second gap which is not primarily represented in the disturbances of viscera. It corresponds to the 2nd, 3rd and 4th lumbar areas. A diagram showing this tract of skin split up into its segmental constituents will be found on page 53.

L. 5 represents the fibulo-dorsal or 5th lumbar area.
S. 1 represents the soleal or 1st sacral area.
S. 2 represents the sciatic or 2nd sacral area.
S. 3 represents the gluteo-pudendal or 3rd sacral area.
S. 4 represents the coccygeal or 4th sacral area.

PLATE I.

A. On the left-hand side of this figure the areas are shown from the front in their entirety. On the right-hand side the maximum spots of each area are figured, and in each case the colour is the same as that of the area to which each spot belongs.

B. This figure gives a lateral view of the areas marked in full on the left-hand side of fig. A.

PLATE II.

C. On the right-hand side of this figure the areas are shown from the back in their entirety. On the left-hand side the maximum spots of each area on the posterior aspect of the body are represented.

D. Shows a lateral view of the body on which the maximum spots of each area are marked as before.

To facilitate the recognition of these areas in any given case, I give a table on which are marked the viscera that are associated with tenderness in the various areas shown on these figures.

	HEART	LUNG	STOMACH	INTESTINE	RECTUM	LIVER and GALL BLADDER	KIDNEY and URETER	BLADDER (Mucous Membrane and Neck)	BLADDER (Over distension or ineffectual contraction)	PROSTATE	TESTIS	EPIDIDYMIS	OVARY	APPENDAGES	UTERUS (In Contraction)	UTERUS (Lower Segment and Os Internum)
D 1	X	X														
D 2	X	X														
D 3	X	X														
D 4		X														
D 5		X														
D 6			X			X?										
D 7			X			X	X									
D 8			X			X	X									
D 9			X	X		X	X									
D 10				X		X	X			X	X		X			
D 11				X			X	X	X	X		X		X		
D 12				X			X	X	X	X?		X		X		
L 1							X	X	X			X		X		
L 5										X						
S 1								X?		X						X?
S 2					X			X		X						X
S 3					X			X		X						X
S 4					X			X								X

BRAIN:

A JOURNAL OF NEUROLOGY

EDITED

FOR THE NEUROLOGICAL SOCIETY OF LONDON

BY

A. DE WATTEVILLE

VOL. XVI.

London:
MACMILLAN AND CO.
AND NEW YORK.
1893.

Reprinted with the permission of MACMILLAN AND CO. LTD.
JOHNSON REPRINT CORPORATION JOHNSON REPRINT COMPANY LTD.
111 Fifth Avenue, New York, N.Y. 10003 Berkeley Square House, London, W1X6BA

BRAIN.
PART III., 1893.

Original Articles.

SOME POINTS BEARING ON THE ASSOCIATION OF SENSORY DISORDERS AND VISCERAL DISEASE.

BY JAMES MACKENZIE, M.D.,
Honorary Medical Officer, Victoria Hospital, Burnley.

In the following pages I deal in a somewhat discursive and desultory manner with the result of several years' enquiry into the symptoms evoked in the sensory nervous system by disease of the viscera. For many years the subject has been present in my mind, and although for a long time I could not appreciate the value of all the phenomena, yet by carefully noticing each circumstance in every case, and by grouping the symptoms together, I formulated for myself certain tentative laws of a somewhat vague nature, trusting that with extended experience these would become more defined and be of a less general nature. What I have published on this subject [1] does not fully accord with the results obtained by Dr. Head,[2] and although in many respects his results are more reliable than mine, there are a few points on which we are in conflict. These points may seem to be here unduly emphasised, but my object in stating them is that a subject of such importance and of such practical utility should be established on a basis

[1] *Medical Chronicle*, August, 1892. [2] BRAIN, Part I. 1893.

which cannot be gainsayed, and that the views of Dr. Head will be enhanced if he is able to rebut objections. On the other hand, these views may be all the better for being modified if they are found irreconcilable with fact. While I, therefore, take exception to some of his conclusions as being too exact, yet I heartily congratulate him on a brilliant and valuable piece of work, and only regret that space does not permit me to emphasise the many points in which my evidence fully supports his conclusions.

In pursuing the study of this subject it is necessary to divest the mind of all preconceived ideas bearing upon it and to note carefully every individual circumstance, however contrary it may appear to one's expectations and desires. One great difficulty is the unreliability of the patient. Pain of the most excruciating kind leaves in the mind but a very imperfect recollection of its exact site. In all cases the description of the pain prior to examination should be received with great caution, and instructions given to note accurately the exact site during an exacerbation or recurrence. In the latter case trustworthy accounts can generally be received even when the observer is not present.

I must confess I have also found it necessary to put a control on my own observations, by having them verified by a colleague. In making my observations I invariably had the most striking and important cases examined independently. Such phenomena as my colleagues could not verify I rejected, for if these sensory symptoms are to be of value they must be capable of being elicited by observers free from bias. And further, cases should not be recorded based upon recollections alone, for it is wonderful how far from the truth the memory may wander, when there is a favourite theory to be advanced.

I.—The Pain in Visceral Disease is a referred Pain.

When I had for some time, in systematically examining patients, employed the site of pain as an important aid to diagnosis, I gradually became impressed with the apparent fact that there was little or no evidence pointing to the situation of the pain in disease of the viscera, being situated

in the organ affected. This view was strengthened by the results of *post-mortem* examinations in two cases of gastric ulcer, where the sites of the ulcers bore no relation whatever to the seat of pain during life. When Ross[1] published his highly suggestive paper, I was greatly helped in obtaining an explanation of many of my observations. In conversation with Dr. Ross I dissented from his view of the so-called splanchnic pain, maintaining that there was no evidence whatever in support of it. He stoutly maintained the contrary opinion, and used as an illustration a case of gastric ulcer that he had then under observation, in whom there was a pain of great severity localised in a limited area. He said he felt convinced that, were he to push a long needle into this painful spot, the needle would inevitably pierce the ulcer. In opposition to this view (which is very widely held), I urged the fact that whilst the site of pain was absolutely stationary, the stomach (and its ulcer) executed movements of a considerable excursion, both by reason of the musculature of the stomach itself, as well as by the mechanical movements of respiration.

My attention being somewhat accidentally called to the presence of hyperæsthesia in a patient recovering from an attack of gall-stone colic, I made careful search for this phenomenon in other cases, and collected a large number of illustrative cases, intending in the first instance to submit them to Dr. Ross as evidence in favour of the somatic origin of his splanchnic pain. But this was never done, on account of his painful illness and deeply regretted death.

The sensory phenomena, besides pain, when present, exhibit an increased irritability of the peripheral nerves. This is evidenced more particularly by cutaneous hyperæsthesia, and exalted sensibility of certain sub-cutaneous tissues of the external body wall. The first of these can be demonstrated by the usual methods for testing the hyperæsthesia of the skin, while the latter can be elicited by lightly grasping the various structures through the skin between the thumb and fore finger. There can occasionally be demonstrated a differ-

[1] Ross, J., "On the Segmental Distribution of Sensory Disorders," BRAIN, January, 1888.

ence in the sensibility to this stimulation in the various sub-cutaneous tissues. Thus, when no hyperæsthesia of the skin exists, as tested by lightly stroking with a blunt pointed instrument, when the skin is grasped in the above manner, abnormal tenderness may be elicited. Similarly when the skin is not unnaturally sensitive the sub-cutaneous fat or mammary glands may be so. And again, while these structures may exhibit no abnormality, certain muscles may be extremely hypersensitive. Further, distinct tenderness may be found in pressure over certain vertebræ, and that when there is no increased sensitiveness of the tissues interposed between the vertebræ and pressing thumb. These tender vertebræ frequently afford very valuable evidence of the organ diseased. When hyperæsthesia of the skin is present along with this tenderness of the sub-cutaneous tissues, the two areas are not co-extensive—the tenderness of the sub-cutaneous tissues generally being spread over a larger area than, and even manifested at some distance from, the cutaneous hyperæsthesia. In such cases, if the nerve supply of the organ affected be carefully enquired into, an explanation will be generally found in the fact that the nerves supplying the organ are in connexion with the spinal nerves at different levels of the cord.

Pain, when felt by the patient in whom there is also increased sensitiveness of certain areas of the skin or sub-cutaneous tissues (limiting the term sub-cutaneous tissues to the structures of the external body wall), is generally situated within the area of hypersensitiveness. Now as these areas are these to which Ross usually referred his splanchnic pain (the pain in the organ itself), it seems but reasonable to expect that the pain would be produced in the nerves thus abnormally excited. That is to say, if the roots of certain nerves are excited to a degree that produces this increased sensitiveness of the external body wall, it may be reasonably assumed that the irritation of the nerve roots also produces the pain which is felt in the area of their peripheral distribution. That a pain can thus be referred has been accepted by many writers, and Ross adopts it in the explanation of the origin of his somatic pain. The only difference between this referred pain—the somatic—and the so-called pain of the organ itself—the splanchnic—is one of locality, the latter having its seat in close relation to the situation of the organ affected. If we take the pain of renal calculus as an illustration, it will be found frequently that the pain extends from the lumbar region round the side and down the abdominal wall slanting inward to the scrotum with, it may be, retraction of the testicle. As it is known that the ureter occupies a somewhat similar situation, it is frequently assumed that the pain in such a case is felt in the ureter itself. But the 12th dorsal nerve in its peripheral distribution follows a somewhat similar course, and frequently after an attack of renal colic, the skin here is hyperæsthetic. It seems, therefore, much more reasonable to assume that the pain here is in reality due to some irritation at the root of the 12th dorsal nerve, and that the pain is felt in the area of cutaneous distribution in accordance with the law of eccentric projection of pain. This assumption is all the more reasonable when there is evidence of the irritation having extended to more distant nerve roots, as when the pain and hyperæsthesia extend to the regions of distribution of the 1st and 2nd lumbar nerves, and even having affected the motor centres, as evidenced by the retraction of the testicle, and feeling of loss of muscular power in the muscles supplied by those nerves.

But it is in the study of the pain in heart affections that the most striking evidence is furnished in favour of the view that the pain in visceral disease is not located in the organ. Many precise observations have been made supposed to demonstrate the sensitiveness of the organ. Walshe[1] and Balfour[2] speak of the heart becoming painful, and Peter[3] has assumed that he could demonstrate this sensitiveness by exerting pressure on the organ. But in such cases where the exertion of this pressure elicits pain it can be readily demonstrated that the pain is really elicited from stimulation of the external tissues.

The hyperæsthesia of the skin associated with attacks of

[1] Walshe, W. H., "A Practical Treatise on the Diseases of the Heart and Great Vessels," London, 1873, 4th edition, p. 208.
[2] Balfour, G. W., "Clinical Lectures on Disease of the Heart and Aorta," London, 1876, p. 274.
[3] Peter, M., "Maladies du Cœur," Paris, 1883, p. 36.

appear typically in regions distant from the heart. The following case is such a striking illustration of this, that on account of its importance I quote it at length.

Case of Chronic Fibrous Myocarditis and Calcification of the Coronary Arteries, with severe pain in the left forearm.—Female, age 60, consulted me on 30th July, 1892, complaining of great irritation in the privates which comes on periodically and sets up a great pain that strikes into the left forearm. These attacks occur several times a day, and last from fifteen to twenty minutes. She feels great depression when the attack comes on. She is very short of breath, and there is slight swelling of the legs. There is considerable difficulty in making water. There is great thirst, fair digestion, and constipated bowels. The patient is pale and wan, and the face has a pained and anxious expression. The body is well nourished. The tongue is very dry. The urine has a specific gravity of 1030, contains a trace of sugar, but from enquiry the quantity of urine passed does not appear to be abundant. The site of the irritation is very definitely limited to the inner surface and skin edge of the vulva. The arteries are large and slightly atheromatous. The pulse is full, soft, quick, and regular. The left side of the chest is tender to pressure, but there is no cutaneous hyperæsthesia. There is a very tender spot on pressure over the 2nd left rib in the nipple line, and the upper 3rd dorsal vertebra is very tender. There is no defined apex beat. The area of the heart's dulness begins at the 3rd rib in the parasternal line, and extends transversely from the middle of the sternum outward to the left for four and a half inches. The heart sounds are sharp and clear in all the areas, but in the aortic area the second sound is markedly accentuated, resembling a drum-tap. There is marked pulsation of the internal jugular veins, and tracings of this pulsation taken at the same time as the radial pulse, show the pulsation to be due to the contraction of the right auricle.

No abnormality can be detected in any other organ. The patient was directed to diet herself carefully, and, for relief of the irritation, to inject hot water into the vagina by means of a Higginson's syringe during the attacks and systematically night and morning. She was asked also particularly to note the exact site of the pain when it recurred and its connection with the irritation in the vulva.

In ten days' time she returned. The pain she found had no relation with the irritation, but came on always with exertion. It was situated in the left forearm, and she defined very clearly the ulnar half of the forearm. Sometimes it was associated with a pain of less severity under the left breast. Under the treatment prescribed the irritation was greatly relieved, and the attacks had become much rarer.

The progress of the case was satisfactory so far as the urinary condition was concerned. The sugar after a few weeks' treatment disappeared from the urine, and the irritation also completely subsided. But the pain in the arm resisted all treatment. On one occasion she came to my consulting room in a terrible state of distress, and sat rocking the body to and fro, nursing her left forearm in her right hand. The onset of this paroxysm of pain had been induced in consequence of her having to hurry to catch the train by which she was coming to consult me. While she was under this attack I made a careful observation of the pulse and the site of pain. The pulse presented no change from its usual character, either to the touch or from the study of the sphygmogram. *The pain was exactly located in the ulnar half of the forearm*, no pain being complained of in any other part.

As I could give the patient no relief, she came into the Victoria Hospital under my care. She was put to bed, and not permitted to get up for three weeks. After the first week she had no attack, and after she was discharged she had them only very slightly and very rarely. I lost sight of her for a few months until the 9th of July, 1893, when she consulted me for an attack of diarrhœa. She said the old attacks of pain had never been so frequent since she had left the hospital, although occasionally they were still very severe, but were always limited to the left forearm. On examination during this visit I found only slight tenderness of the 1st dorsal vertebra and of the sub-cutaneous tissues in its neighbourhood. The heart presented no change except that the second sound, although still markedly accentuated, was not quite so clear, being somewhat muffled. She had her left forearm carefully wrapped in flannel, under the impression that it eased the attacks. There was no sensory abnormality demonstrable in the arm. On the 22nd I was asked to see her, as she was very ill. I saw her on the 24th. She was propped up in bed suffering from great dyspnœa, and the legs were greatly swollen. She died next morning.

Permission to examine the heart was obtained with difficulty, and only an incomplete *post-mortem* was therefore held. I sent the heart (which was empty and flabby) to Dr. Williamson, of Manchester, and his report is as follows:—

angina pectoris is no new thing, several writers mentioning the observation. It is needless to affirm, however, that a great many cases of angina pectoris suffer typical attacks without any symptom of peripheral hyperæsthesia, either of the skin or subjacent tissues. Such a case presented itself to me a short time ago where the patient died in the second attack of pain. In him no other sensory abnormality whatever could be elicited. The pain was situated across the lower third of the chest, extending slightly to the left. In such a case one might assume that the pain was undoubtedly in the heart. But is it so in reality? During the period that a patient suffers from an attack of angina pectoris the heart's movements still continue. The movement of such an abnormally sensitive organ would surely cause some variations either in the intensity or in the situation of the pain, and of this there is no evidence. Further, the pain of angina pectoris very often extends over a greater area than that covering the heart. In many cases this extension of the area takes place in a manner very instructive. In the first instance the attacks of pain may be limited to the præcordial region. As they increase in severity they extend further round the left chest and towards the arm-pit, and it may be down the inside of the left arm. The pain appears to be exactly of the same nature in the more distal parts as it is when it is located in the præcordia. It is a mere assumption to say that in the one instance the pain is in the heart, and when felt in more distant regions that it is due to reflex irritation of the spinal roots, particularly when the cutaneous area over which the pain is felt is supplied by nerves whose spinal roots are in immediate contiguity. This is more strikingly demonstrated when hyperæsthesia of the skin is likewise present. In such a case the pain is situated within the hyperæsthetic area, and this area can be demonstrated to be the region of cutaneous distribution of the 4th, 3rd, and 2nd dorsal nerves. The pain may even not be felt in the region of the heart at all. From the study of a series of cases extending over a period of years during which I have observed the attacks of angina pectoris first appear and develop, I have been able to observe a great diversity in the modes of attack. Although the symptoms of

pain are usually præcordial at first they are not invariably so. In one patient whom I have had under observation for two years with symptoms of aortic stenosis, the pain and hyperæsthesia in the first instance were situated over the anterior axillary wall and in the arm-pit. Lately the attacks have developed with extreme severity, and the hyperæsthesia now embraces the upper part of the left chest with the inner half of the left upper arm, the ulnar half of the forearm, and the little finger. There is also extreme sensitiveness of the left sterno-mastoid and trapezius muscles. This distribution of the pain and hyperæsthesia is so characteristic, as to leave no doubt of the distinct connection of the cardiac nerve supply with the nerve roots in the spinal cord supplying those hypersensitive structures. Thus the hyperæsthesia of the chest and arm is practically the field of cutaneous distribution of the upper four dorsal nerves of the left side, the roots of these nerves being connected with the sympathetic fibres that supply the heart. The tenderness of the sterno-mastoid and trapezius muscles, indicate irritation at the root of the spinal accessory nerve, and it apparently receives the stimulation from the heart through the medium of the vagus, the roots of the vagus and spinal accessory being connected. The sensory phenomena exhibit great variation in the locality of this distribution. Sometimes the dorsal nerves show no cutaneous hyperæsthesia, while the cervical nerves do. I have at present under observation a patient who has marked attacks of angina pectoris, and these I have noted developing during a number of years. In her there is very slight tenderness of the deeper tissues of the thoracic wall, whilst the left sterno-mastoid and trapezius muscles are extremely tender and the hyperæsthesia of the skin is limited to the left side of the neck, in an area corresponding to what I take to be the peripheral distribution of the 3rd cervical nerve.

But while most of the cases show the pain limited to, or originating in the præcordial area, other rare cases, manifest attacks of angina pectoris, which have no relation to the chest wall. In such cases the term angina *pectoris* is certainly a misnomer, but taking the term to imply that severe pain associated with disease of the heart, it will be found to

Heart weight, 10½ oz. Left ventricle slightly enlarged, very slight thickening of aortic valves. Pulmonary, mitral and tricuspid valves normal. No atheroma of the aorta. The muscle wall of the left ventricle is of normal thickness and consistency; but in the cut surface there are a number of small pale whitish patches of irregular size and shape. Both coronary arteries are markedly atheromatous and calcareous from their aortic origin down to their small sub-divisions. The main arteries and their chief branches can be dissected out as calcareous tubes. The cardiac muscle of the left ventricle when examined microscopically does *not* present any signs of fatty degeneration (osmic acid). Sections show patches of fibrous tissue amongst the muscle fibres.

The pathological diagnosis is *marked atheroma and calcification of the coronary arteries; chronic myocarditis (fibrous)*.

There can be little doubt that the cause of the pain in this case was situated in the heart. Putting aside the situation of the pain, all the other phenomena pointed to the heart as being the *origo mali;* as, for instance, the suddenness of the attack engendered by exertion, the dull, terrible agonising nature of the pain, and the great sense of oppression accompanying it. The peculiar face of the patient was to my mind also characteristic of the expression in patients who suffer much pain associated with disease of the heart. Concerning the situation of the pain, it was at last entirely situated in the arm. Occasionally at first she did complain of pain under the left breast, but in the few attacks which I have witnessed the pain was entirely located in the arm. And the area here was extremely definite in its limitations. When asked as to its situation she always stroked the ulnar border of the forearm from the elbow to the wrist. There was never any other disorder of sensation in this locality, neither of the skin nor deeper tissues.

The area, then, in which this pain was felt was in the region of cutaneous distribution of the 1st dorsal nerve. Considering the marked disease of the heart substance and of the coronary arteries, there seems little doubt but that the stimulation from them proceeded to the root of the 1st dorsal nerve, and the pain was then referred to its cutaneous distribution. Suppose now that the area of pain had corresponded to the area of distribution of the 3rd or 4th dorsal nerves in the chest—a circumstance far from unusual—would not one have said then that the pain was felt in the heart itself? And this view would have seemed all the more probable if there were complete absence of hyperæsthesia. It seems to me, in view of such a striking example as this case presents, that there is room for great doubt that the pain of an organ is necessarily situated in the organ simply because the pain may happen to be located in its neighbourhood. The pain in angina pectoris may extend in a direction the reverse of the course usually pursued, originating say at the wrist, and extending up the inside of the arm to the chest. Here it would seem that the irritation first affecting the root of the 1st dorsal spreads to neighbouring roots—characteristic of the manner in which the area of pain extends in diseases of other organs. Yet Walshe[1] looks upon such a manifestation as being an instance where "the brachial pain played the part of an aura."

Studying the subject from a purely clinical aspect, such are, in brief, some of the reasons that influence me in considering the pain of visceral disease to be of a referred character, always somatic, never splanchnic. I willingly admit I am not able to explain the source of all pains, and many patients complain of pain to me unexplainable. Yet with this view present in my mind, and with extended experience these cases become less numerous.

II.—The Sensibility of the Visceral Tissues.

A certain amount of light is thrown upon this subject when the sensitiveness to stimulation of the viscera is considered. The relative great bulk of the organs to the nerves that supply them and the varied functions these nerves subserve, suggest the idea that there can be but a very limited amount of sensibility.

[1] *Loc. cit.*, p. 198.

In considering this subject it will be convenient to divide the tissues constituting the viscera into three, namely, the serous, muscular and glandular. This division will be useful in considering not only the sensitiveness of the tissues to ordinary stimulation, but also in considering the sensory disorders that arise during affections of the individual organs. To the methods employed for ordinary stimulation (touching, pricking, pinching, &c.) it is well known that the viscera are insensitive. But still, painful sensations can be aroused, and the symptoms thus elicited help in clearing up a good many obscure phenomena.

(A) *Serous Membranes.*

For many years when tapping for pleurisy I have been accustomed to note the sensations elicited when the visceral pleura came in contact with the canula. Coughing has been set up, but never any pain or other sensory phenomena. In like manner on testing the parietal and visceral pleuras with more facility in cases of excision of the ribs, I have failed to elicit any painful sensation. Richerand[1] long ago noted the insensibility of the pericardium, which he exposed in removing a portion of a scirrhus pleura. The insensibility of the peritoneum has been frequently demonstrated in operations affecting the various abdominal and pelvic viscera.

(B) *Muscular Tissue.*

In hollow muscular organs pain can be elicited by stimulating the muscle to contract, as after giving a distending enema the great gut contracts producing a referred pain in the abdominal wall midway between the umbilicus and symphysis pubis. The uterus can be made to contract, with the production of the pain in a similar area. The pains may extend in both cases to other regions, but in no sense are they felt in the contracting organ. But to any stimulation, save that which gives rise to powerful contraction, the muscular is as insensitive as any of the other tissues.

[1] Richerand A., "Elements of Physiology." Edited by James Copland. 2nd edition, 1829, p. 613.

The insensitiveness is still marked when the parts are inflamed. In a patient from whom a large piece of gangrenous intestine had been removed, the exposed gut a few days after was deeply congested and swollen. But stimulation of the peritoneal and mucous surfaces and intervening tissues was not perceived by the patient.

Seeing that it is the muscular tissues that evolve pain most readily, it will be best to study shortly the sensory phenomena associated with the hollow muscular viscera. No one doubts but that the pain felt during painful peristalsis of the bowel, or during uterine contractions, is produced by the muscular tissue. The pain so produced may be still felt after the contraction has ceased as a feeling of soreness, and hyper-æsthesia can frequently be demonstrated. It is a curious fact that the pains, and other sensory disorders that are most severely felt by patients, are those that arise from affections of the hollow muscular organs. I do not mean to imply that spasm of the muscle is necessary to the production of pain. In angina pectoris, this is manifestly not the case, notwithstanding many opinions to the contrary. But the pains, for instance, that are the most marked and can be referred with most certainty to the organ affected, are those of the heart, of the stomach, small and great intestine, and of the uterus. The pains, likewise, of gall stone and renal calculus are in all likelihood essentially those of hollow muscular organs. The calculus lodged in the substance of liver and kidney gives rise to no sensory symptom, but when it invades the hollow viscera connected with them then the pain is aroused. I have had frequent occasion to observe the persistence of pain, and hyperæsthesia after the expulsion outside the body of gall stone and renal calculus. In view of the possibility of these symptoms, and those also manifested so frequently in stomach affections, being associated with and probably due to spasm of muscular tissue, the following remark by Beaumont in his observation upon Alexis St. Martin is of interest.[1] "If the bulb of the thermometer be suffered to be drawn down to the pyloric extremity, and de-

[1] Beaumont, W., "Experiments and Observations on the Gastric Juice, &c." Edited by A. Combe, Edinburgh, 1838, p. 105.

tained there for a short time, or if the experiment be repeated too frequently, it causes severe distress, and a sensation like cramp or spasm, which ceases on withdrawing the tube ; but leaves a sense of soreness and tenderness at the pit of the stomach." I have little doubt in my own mind, but that the tenderness and soreness here described, was in reality due to a condition of hyperæsthesia of the skin or subjacent tissues. I usually find these phenomena when patients complain of such feelings in the epigastrium. In a case of lax abdominal walls Macdonnell[1] was able to palpate the under surface of the heart, and pressure upon the auricles gave rise to symptoms resembling angina pectoris. Without seeking, therefore, to insist that the pain in visceral disease is due in all cases to muscular spasm, I would seek to point out, first, that pain and other sensory phenomena are frequently associated with hollow muscular organs ; second, that symptoms exactly analogous to these produced by disease can be originated by artificial stimulation of the muscles of hollow organs.

(c) *Parenchymatous Tissues.*

Diseases of the parenchyma of an organ are not associated with very definite sensory symptoms. In fact, I have more than a suspicion that there are none. I have carefully enquired into the history, and watched the progress of many cases of acute nephritis from the onset, and yet have been unable to find any sensory symptom associated therewith. The ravages of consumption are notoriously painless, unless the pleura be involved. The pains of pneumonia are those observed in pleurisy.

A certain amount of pain can be elicited by pressure on a number of the organs (kidney, testicle, ovary, &c.). But here, so far as I have been able to make out, the pain is a referred pain.

When pain occurs associated with disease of an organ, it can frequently be demonstrated that there is an extension to the serous covering, as in the pleurisy of pneumonias. I have had frequent opportunities lately of studying the pains associated with great enlargement of the liver from disease of the heart. In such cases pulsation of the organ is a frequent symptom, and in the course of an enquiry into the nature of this pulsation, I noted the frequent occurrence of pain over the distended organ. So far as I could make out it was evidently on the surface of the organ, and in one case where the pain and tenderness were very marked, there were found in the *post-mortem* examination numerous adhesions between the anterior surface of the liver and the abdominal wall.

[1] Macdonnell, H., "Cardiograms from the Human Heart," *The Practitioner*, vol. xliv., 1890, p. 178.

I have already referred to the pains associated evidently with the ducts of certain organs (bile ducts, ureters), and it is a fact worth noting that diseases of a ductless gland like the spleen appears to be unaccompanied by any sensory symptoms. One great obstacle in regard to this theory of the painlessness of parenchymatous disease, is the pain associated with orchitis, unless it be due to the swelling pressing on the more sensitive tissues external to the organ. Otherwise, why inflammation of this organ should produce such pain, and inflammation of the kidney should be painless, I do not understand. I am conscious that many very capable physicians affirm with great assurance that there are pains distinctly associated with disease of the parenchyma of organs. But all I can say is that looking at the matter dispassionately I have yet found no distinct evidence of such a thing, and I do not feel justified in ascribing a pain, whose origin I do not know, to an obscure organ whose sensory manifestations I do not understand.

III.—The Character and Distribution of the Sensory Symptoms in Inflammation of Serous Membranes.

When all the sensory symptoms that can be elicited from a series of cases of inflammation of the pericardium or pleura, are grouped together, it seems very difficult to find a satisfactory explanation for them.

The assumption that the pain is local and due to stimulation of the peripheral nerves, the view most commonly held and supported by Ross and Head, as distinct from a reflex or associated pain, is not sufficient. A great variety of these sensory phenomena may present themselves in cases that are otherwise apparently identical so far as our means of physical

diagnosis are concerned. In looking over my notes of six cases of pericarditis I found that two presented no sensory phenomena, that a third had a slight pain referred to the upper part of the præcordial region, that a fourth had pain for a few hours of agonising severity across the middle of the sternum. I was summoned to see this patient between three and four in the morning, and the symptoms resembled those of an attack of angina pectoris—the ashen hue of the patient's face, the fear of impending death, and the agonising pain. The pulse was quiet and regular, and the only abnormality was a to and fro murmur over the area of the heart's dulness. After the subcutaneous injection of a large dose of morphia the pain abated. Later in the morning the pain had entirely gone, and the friction murmur had nearly disappeared, and in a couple of days had entirely disappeared. Since then (three years ago) the patient has had no recurrence. The last two cases presented somewhat similar phenomena; one of them only I will detail.

Case of Pericarditis with marked sensory disorders.—Male, aged 23, thin and meagre, had been under my care occasionally for nine months, chiefly on account of obscure abdominal symptoms (pain and diarrhœa). I had kept him under observation chiefly on account of marked pulsation in the veins of the neck and sometimes in those of the chest wall. The venous pulse was of the auricular type, *i.e.*, the main wave of the pulse was due to the auricular systole. There was also a marked extension of the heart's dulness to the right of the middle line for two inches. He had occasional attacks of violent palpitation in the night. On the 18th March, 1893, he left his work at eleven in the morning, feeling tired and exhausted. On the 21st he was seized with a pain of great severity in the chest, with difficulty in breathing. I saw him on that day and found him sitting up in bed, holding his body very rigid and breathing with evident difficulty, and on his face an expression indicative of great suffering. The pain struck from the præcordial region round to the left shoulder blade (so that he could not lift his left arm) and down the inside of the left arm and ulnar part of the forearm to the little finger. Any movement of the body caused pain, and he was too terrified to take a deep breath. There was extreme tenderness of the skin and sub-cutaneous tissues over the whole front of the chest as far out on both sides as the nipple line. Over the 3rd left costal

cartilage and adjacent portion of the rib, this tenderness to pressure was excessively acute. Careful note was made that the tenderness referred entirely to the tissues in the external body wall, and that the method to elicit this tenderness did not affect the heart substance. The pectoral muscles, and the structures forming the anterior and posterior walls of both axilla were also very tender. There was also slight tenderness to pressure of the left sterno-mastoid and trapezius muscles, one point over the trapezius immediately above the middle of the scapular spine being especially tender. The muscles over the back of the scapula were also very tender. On auscultation over the heart, a loud to and fro friction murmur could be heard over the whole heart. There was no murmur accompanying the heart sounds. The pulse was quick, small and regular, 110 per minute. The temperature was 103° F.

For three days these symptoms remained practically unaltered, the pain only yielding to large doses of opium. During the time he was so ill I asked two of my colleagues to visit him, who verified the diagnosis and the above description of the symptoms.

(In view of the resemblance of the symptoms in these cases to those of angina pectoris associated with disease of the myocardium, the suggestion has occurred to me that it is possible that the pain, even of pericarditis, may be due to the invasion of the muscular tissue of the heart by the inflammation).

In pleurisy similar phenomena are sometimes met with. Thus in a case recently under observation, the onset of well-marked dry pleurisy gave rise to no pain whatever. The friction was at first limited to the right base, and attention was only directed to the condition by a sudden rise in temperature. The friction extended after a couple of days round to the front, and could be heard over the lower third of the chest wall; at the same time symptoms of pain and tenderness on pressure were developed. There was no cutaneous hyperæsthesia, and the tenderness was well-marked on percussing the chest. This tenderness extended higher than the friction sounds, and it is quite possible that the pleurisy extended over a greater area than that over which the friction was heard. There was no tenderness, however, of the chest wall behind the posterior axillary line, although the friction sounds were heard over this area in

the lower part of the chest. But the interesting point in this case was the tenderness of the muscles forming the anterior and posterior walls of the right axilla. Thus, on gently grasping the skin no increased sensation was produced, but on grasping as gently the muscles, then the patient winced from the severity of the pain. On the other hand, no symptom of pain was elicited on applying the same test on the left side. Without entering minutely into the particular nerves here manifesting this abnormal sensitiveness of the axillary walls, it may be pointed out that none of them came within the region of the inflamed pleura.

Hilton has remarked upon the sensitiveness of the skin in pleurisy, and evidently considers it as due to reflex stimulation of the nerve root, comparing it to the pain felt on the inner side of the knee, in disease of the hip joint. In fact, Hilton bases an elaborate argument upon the intimate association of the nerves supplying a joint, the muscles acting upon the joint and the skin covering the muscles, and looks upon the great serous cavities as being analogous to the joints of the extremities. I have frequently observed well-marked hyperæsthesia in cases of pleurisy, and that in a situation that could not be explained by the pleurisy affecting the branch of a nerve and so producing the hyperæsthesia.

Case of Basal Pleurisy with abdominal Hyperæsthesia.—Female, aged 31, complains of pain in her left side, especially on taking a deep breath. The patient is thin, but fairly nourished. She lies in bed slightly propped up. The temperature is 100° F. The respirations are quick (32 per minute) and shallow, and each respiration is suddenly checked. The pulse is 104 per minute, small and regular. There is great pain and soreness in the left hypochondrium. An area of hyperæsthesia can be readily mapped out, extending as a band from near the middle line in front round the left side of the abdomen to the spinal column. The breadth of the band is about three inches. In the front the umbilicus is situated opposite the middle of the band, and at the sides it crosses the tips of the floating ribs, and terminates behind opposite the 12th dorsal and 1st lumbar vertebræ. The edges of the band are not well defined. The chest is resonant on percussion, and on auscultation the only abnormality is a small

area over which friction is very distinct at the base of the left lung behind. These symptoms persisted for a couple of days, then disappeared together, that is to say, on the third day the temperature was normal, the respirations quiet and free from pain, the hyper-æsthesia was gone, and no friction could be detected.

I have, in a great number of cases of pneumonia, found a patch of hyperæsthesia over the area in the abdomen where pain is so frequently complained of in such patients. This abdominal pain of pneumonia is a well-known symptom, but its association with hyperæsthesia has not been sufficiently recognised, although Valsalva mentions it in a case quoted by Morgagni.[1] I have rarely found it quite so extensive as in the above case, and I have always viewed it as being associated with diaphragmatic pleurisy, a view that finds support in the symptoms of such cases as the one just recorded.

A shoulder pain associated with disease of the abdominal organs has long been recognised, and has been the object of particular study by Peter,[2] who associated it with the phrenic nerve, irritation being conveyed by this nerve to the roots of the cervical nerves, and the pain referred to their cutaneous distribution—a view that receives the support of Ross. In several cases of basal pneumonia and of pleurisy limited to the lower margin of the lungs I have found not only this shoulder pain, but also a distinct field of hyperæsthesia on the shoulder. In such cases I have attributed the shoulder pain and hyperæsthesia to the accompanying diaphragmatic pleurisy (although it may be due to the vagus terminations being involved by the inflammation of the lung). It is difficult to account for these phenomena satisfactorily. Hilton describes the parietal pleura as being supplied by intercostal nerves. If so, they must be very scant. Some years ago I made a careful dissection of several intercostal nerves, first following the trunk of the nerve and

[1] Morgagni, H., "De sedibus et causis morborum," book ii., letter xx., article 30.

[2] Peter M., "Névralgie diaphragmatique," &c. *Archives Générale de Médecine*, June 17, 1871.

tracing each twig to its destination, but I could not find a single filament going to the pleura.

If the suggestion be found tenable that the far-reaching pain and hyperæsthesia accompanying pericarditis is due to an extension of the inflammation to the myocardium, then the abdominal and shoulder pains of basal pleurisy may in like manner be due to an invasion of the muscular tissue of the diaphragm by the inflammation.

Of the sensory phenomena associated with disease of the peritoneum I have very little experience, and I am unable to give any definite results. I may say that since I recognised the hyperæsthesia associated with diseases of definite organs, I have had fewer cases of "peritonitis"—for sometimes the hyperæsthesia in, say, a case of pyelitis with retention of pus, gives rise to symptoms resembling the descriptions of extreme tenderness of the abdomen in cases of peritonitis.

When, however, the various sensory disorders associated with the diseases of the serous membranes are considered, there is some difficulty in getting a clear conception of how they are produced. At all events, the statement that "affections of the serous cavities of the body do not cause referred pain or cutaneous tenderness, but produce local pain which follows the lines of peripheral nerves, and is associated with deep tenderness over the affected point only" (Head) is not sufficient explanation for the conditions present in such cases as I have quoted above.

If this view of the absence of pain in the viscera be substantiated, it would lead one to surmise that the great organ of sensation, the skin, is altogether a later development in animal life, having for its function the protection of these viscera necessary to the maintenance of organic life. The sympathetic nerves would therefore have functions apart, and distinct from those of the spinal nerves. This independence of the sympathetic nervous system has received a very elaborate exposition by Davey.[1] Support

[1] Davey, J. G., "The Ganglionic Nervous System," London, 1858.

for this conjecture is found in the recent observations of Paterson,[1] who maintains that the sympathetic nervous system is developed independently in the mesoblast, and does not arise as an outgrowth from the cerebro-spinal system. The elaboration of this view necessarily leads to the discussion of matters pertaining to morphology and development—subjects which I am not qualified to discuss.

IV.—The relationship between the Areas of Cutaneous Hyperæsthesia associated with Visceral Disease, and the Areas of Cutaneous Distribution of Spinal Nerves.

In my earlier observations I had come to the conclusion that when there was a limited field of hyperæsthesia in any given case of visceral disease, it occupied a situation in some part of the cutaneous field of distribution of a spinal nerve, whose root was in intimate association with the root of the sympathetic nerves that supplied the affected organ. When the hyperæsthesia became more extensive, it spread in a somewhat diffuse manner into fields occupied by spinal nerves, whose roots are in close relation with the one originally affected. While, therefore, there was a continuity in the skin area affected, that continuity always occurred in a definite direction, namely, in accordance with the distribution of the spinal nerves whose roots are in close association. Thus, the hyperæsthesia in heart affections beginning in the 4th dorsal nerve distribution might spread up the chest, but instead of passing over the clavicle into the field of supply of the 4th cervical it passes down the arm along the fields of supply of the 3rd and 2nd dorsal. In spreading thus it did not necessarily affect the whole area of supply of one nerve root. Thus, one portion of the field of supply of the 4th dorsal nerve might be hyperæsthetic. As this area increased in size, it did not first spread over the whole field of supply of the 4th nerve, then invade the field of supply of the 3rd. Occasionally it might do so, but more frequently if the area was limited, as it usually is, to the anterior surface of the chest;

[1] Paterson, A. M., "Development of the Sympathetic Nervous System in Mammals," *Philosop. Trans.*, 1890.

this area would extend into the armpit and down the arm without involving the posterior surface of the chest. There does not appear to be any law regulating this spreading. Thus, in four cases of gastric ulcer at present under observation, in all of whom there has been lately vomiting of blood, an examination shortly after the hæmatemesis revealed the following conditions relating to the sensory symptoms. In two there are absolutely no sensory symptoms. In one there is well-marked hyperæsthesia in the epigastrium shading off into a less definite field of hyperæsthesia that extends from the level of the umbilicus round to the left to the spinal column, and up over the thorax and down the inside of the left arm, and the ulnar half of the forearm to the little finger. In the fourth case the hyperæsthesia occupies the front of the abdomen, reaching on both sides as low as the groin, with a tongue-like projection into the front of the thighs, similar to that Head maps out as being characteristic of the distribution of the 12th dorsal nerve. On the right the hyperæsthesia reaches as high as the umbilicus, and on the left as high as the ensiform cartilage. It does not extend backwards on either side beyond the anterior axillary line. In this latter case there is remarkable extension of the area in which the uppermost epigastric reflex can be produced. In many persons the reflex contractions of the rectus abdominis muscle above the epigastrium can be observed to occur in three divisions corresponding doubtless to the divisions produced by the tendinous intersections. In this patient stimulation of the skin as high as the nipple frequently (and sometimes even the skin in the axilla) will provoke a contraction of the upper portion of the rectus on the left side. The skin here is not hyperæsthetic in the slightest degree.

V.—Overlapping of Sensory Fields.

In very few of the cases could the field of hyperæsthesia be delimited with certainty. Parts at the border would be hyperæsthetic at one time, and when one would return there would be some doubt, or a distinct assertion that the part was not hyperæsthetic. In the centre of any limited area the hyperæsthesia was more acute. Under these circumstances I did not think that the hyperæsthesia associated with visceral disease afforded a sufficiently accurate clue to the delimitation of the areas supplied by individual nerves, and I looked upon this variation in the intensity of the hyperæsthesia as being due to an over-lapping in the distribution of neighbouring nerves. This view was strengthened by the fact that I had seen evidence of a slight extension of the hyperæsthesia into fields supplied by nerves whose roots were not in neighbouring association. I considered also that I had obtained evidence of this overlapping from the study of the eruption in cases of herpes zoster.[1] When Dr. Head published his extremely exact delimitation of the fields, I imagined that I had not been sufficiently accurate in delimiting my fields. I therefore made another series of careful observations, and although in a few cases I appeared to get results that partly supported his views, I must confess to having utterly failed in the great majority of cases. Even in the study of a few cases of herpes zoster I could not get them to fit into any one of his fields. To demonstrate these several points I will quote the following three cases that merit publication for other reasons.

Case of Herpes Zoster without eruption.—Male, aged 53, complains of pain on the top of the right shoulder extending down the arm to the thumb. The pain began about three weeks ago, and has continued ever since. Sometimes it comes on in severe paroxysms, accompanied by a disagreeable smarting sensation. He can scarcely bear his clothes to touch his shoulder, and he can't wear his braces over the right shoulder because of the pain it causes. The paroxysms of pain have prevented him sleeping of late, and in consequence he is getting tired and weak. The patient is a big, stout man of healthy appearance. When stripped there is nothing abnormal to be observed in the skin of the right shoulder or arm. On testing the sensation, the skin on the top of the shoulder is markedly hyperæsthetic. The hyperæsthesia occupies a very characteristic situation, which can be easily mapped out, as it is so acute the patient has no hesitation in noting when the stimulation passes from the healthy skin to the abnormally sensitive. It begins abruptly in the neck about the level of the 3rd cer-

[1] Mackenzie, J., "Herpes Zoster and the Limb Plexuses of Nerves," *Journal of Pathology and Bacteriology*, vol. i., p. 332.

vical vertebra, and extends round the neck at that level to the middle line in front. It extends from hence over the top of the shoulder down the outer surface of the arm, and radial half of the forearm to the thumb. The posterior border of this area extends from the 3rd to the 6th cervical vertebra, then slants outwards at the level of the spine of the scapula to the posterior surface of the shoulder, then down the back of the arm past the side of the olecranon into the forearm to the thumb. The anterior border descends in the middle line to the level of the clavicle where it slants slightly outwards to the level of the third rib. It then runs transversely out to the front of the shoulder, where it descends in the front of the arm and forearm to the thumb (fig. 1). This area, although so distinct, does not evince the hyperæsthesia with equal intensity in all parts. Thus in testing round the arm, when passing from the healthy skin, the hyperæsthesia at the borders is not

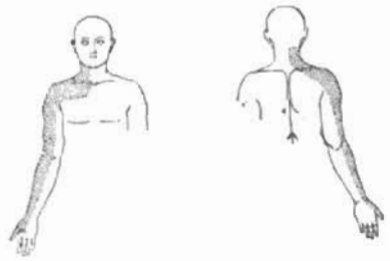


FIG. 1.

so acute as towards the centre of the affected area. The under surface of the thumb is slightly anæsthetic. The same results are obtained on testing by heat.

Careful enquiry was made into the condition of all the other organs, but with the exception of a slightly furred and fissured tongue no abnormality could be detected.

The patient called to see me at intervals of five or six days, and each time I mapped out the hyperæsthesia, the results always being practically the same. In a month from the date of his first visit the hyperæsthesia had gone, and with it to a great extent the pain. For several weeks later the pain used to recur in slight paroxysms.

I have assumed this case to be one of herpes zoster, although in the strictest sense it has no right to the term herpes or zoster. But that it is essentially the same disease I have little doubt. The description of the pain—the

paroxysms, its wearing character preventing sleep, and its duration are exactly the symptoms described by patients who suffer from herpes. Although I have never read of any account of herpes zoster without an eruption, I think that it may not be so very rare. Some years ago I saw in consultation a patient said to be suffering from some painful disease of the spine. In her there was a distinct area of hyperæsthesia following the distribution of the 4th dorsal nerve. The pains were characteristic, and located chiefly within the hyperæsthetic area, but radiating into the arm. I detected on the back two small vesicles, and on the strength of this, suggested the diagnosis of herpes zoster. The medical man in charge attributed the blisters to his applications, but on enquiry they were not such as would give rise to vesication. The future progress fully confirmed this view of the case. Lately I had a patient with severe pain in her side, and a distinct band of hyperæsthesia embracing one half of the body. I was a few days in doubt what might be the nature of the complaint until it was disclosed by the appearance of a few vesicles in the epigastrium, the remainder of the hyperæsthetic field remaining quite free. Dr. Head has likewise noted similar cases, and von Bärensprung,[1] has described the intervals of skin between the eruption as being hyperæsthetic. So that it would appear that an eruption is not a necessary symptom in herpes zoster.

On the question of differential diagnosis the only alternatives that occur to me, are that this case was an irritation of nerve roots due either to disease of the vertebræ or to some visceral lesion. That it was not due to a disease of the bones is evident from the progress of the case. There was never any spinal tenderness. I made, as I have said, enquiry into the condition of all the other organs in the head, throat, thorax, and abdomen, but could find no clue. The vagus and phrenic roots being in association with the cervical nerves led me to make careful examination of the organs supplied by them, but the quest was vain.

For these reasons I consider the case as being due to an

[1] Von Bärensprung "Die Gürtelkrankheit," *Annalen des Charité-Krankenhauses*, Band ix., Heft. 2, 1861, p. 103.

affection of the roots of the 3rd, 4th, 5th, and 6th cervical nerves, and to be of the same nature as that which gives rise to the disease known as herpes zoster. And the case illustrates in a very definite manner the cutaneous area supplied by these nerves. The relations of this area to neighbouring areas are of considerable importance, and will be referred to later.

Herpes Zoster of the 3rd dorsal nerve with Hyperæsthesia.—Female, aged 13, has been under my care for over a twelvemonth for mitral disease, with symptoms of cardiac failure. On the 10th August, 1893, I was consulted because of an eruption that had broken out on the right chest. There was very little pain except on the inner side of the right upper arm. The eruption consisted of clusters of vesicles disposed as an interrupted band round the upper part of the chest and down the inside of the forearm. In front the clusters were continuous at their borders and represented a band about two inches broad. The most internal portion was situated over the sternum opposite the 4th costal cartilage. A few vesicles trespassed across the middle line for quarter an inch. From here the band extended outward and slightly upward, crossing over the 3rd rib to the front of the shoulder. A few scattered vesicles extended as high as the 2nd rib, and as low as the nipple—some being situated on the nipple. Behind the eruption extended as a somewhat broader band from near the spinal column, the centre being opposite the 2nd dorsal vertebra, outward and slightly downward over the scapular spine to the posterior axillary fold. On the right arm the eruption occupied the inner surface, two streaks occurring on the anterior and posterior axillary folds, and other two streaks occupying the anterior and posterior surfaces of the inner aspect about the lower third of the upper arm. Surrounding the area of eruption was a wide field of hyperæsthesia. In front it was as high as the second rib and crossed the middle line for at least one inch. Behind it ascended as high as the level of the 7th cervical vertebra and also crossed the middle line for a very short distance. It descended the side of the chest in an irregular manner as low as the 10th rib. It also descended the arm embracing the area of eruption. The interrupted line in fig. 2 shows the hyperæsthetic area.

The hyperæsthesia in this case extends somewhat diffusely, yet in a definite manner. The irritation from the diseased root that produces the eruption spreads to neighbouring nerve roots. But in doing so it evidently does not necessarily affect

the whole of one root before it passes to the next. Just as was pointed out in relation to the hyperæsthesia associated with visceral disease, contiguous fields are affected, without of necessity the whole area of supply of individual nerve roots being affected. The extension of the hyperæsthesia likewise takes place in a definite direction, not passing for instance over the clavicles into the field of supply of a distant nerve root, but descending on the arm.

A comparison of these two cases also shows a distinct overlapping of nerves. While it is difficult to prove this overlapping by the study of areas supplied by neighbouring roots, the opportunity is readily afforded when contiguous areas of skin are supplied by nerves whose roots are wide apart.

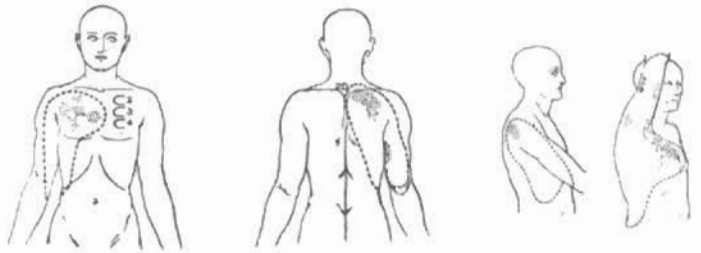


FIG. 2.
The interrupted line embraces the hyperæsthetic area.

Thus the skin of the upper part of the chest is supplied by the 4th cervical that descends over the clavicle as far as the 3rd rib in fig. 1, while the area supplied by the upper dorsal nerves ascends as high as the 2nd rib, as in fig. 2. This overlapping can also be seen at the back in these figures. This same spreading of the nerve supply of one field into that of another is also demonstrable in the crossing of the hyperæsthesia to the opposite side in fig. 2. The eruption has also crossed for a very short distance, and this was more unmistakably demonstrated in fig. 3.

I have been unable to find in my cases of herpes that accuracy of delimitation that Dr. Head describes. If the eruption in fig. 2 be studied, it will be found to occupy a fairly distinct field. The bands on the front and the back of the chest represent a fairly distinct continuity. But they

will be found to correspond to none of the single areas described by Dr. Head. As a matter of fact, the eruption trespassed into the areas that he reserves for the 1st, 2nd, 3rd, 4th, and even 5th dorsal nerves. Yet the continuity of the eruption suggests to me very strongly the idea, that there is but one nerve root affected here—in all probability the 3rd. In fact, I look upon it as being a more complete delimitation of the same field that his case 14, fig. 13, imperfectly represents. This is, I think, strikingly evident in the posterior band, where it cuts by a straight band the wavy contours that he depicts. In making my notes of this case I carefully copied the outlines of Dr. Head's fig. 13, in order that the comparison might be as true as possible. These copies made by me were repeatedly verified.

As a further illustration of the disagreement of my observations with those of Dr. Head in this exact delimitation of the field of supply by individual nerve roots, I give the notes of another case of herpes zoster under the care of my friend Dr. Harwood, to whom I am indebted for the opportunity of seeing the case, and for his kindness in verifying the particulars.

Dr. Head describes the lower border of the field of supply of the 12th dorsal nerve as sending two tongue-like projections down, one on the front of the thigh, and the other over the side of the haunch. These depressions dovetail into the field of distribution of the first lumbar. In a few cases I have certainly found the area of hyperæsthesia associated with disease of certain organs assume this shape. But that it represents the exact limits of the 12th nerve only is not supported by the symptoms in the following case.

Case of Herpes Zoster of first lumbar nerve.—Female, aged 50, suffers from attacks of excruciating pain round the right hip, where an eruption has broken out. The eruption extends from the vertebral column at the lower lumbar region round the right hip to the front and inner surface of the thigh in a band from four to five inches in breadth. Its superior border is extremely well defined, slanting in almost a straight line from the vertebral column at the level of the iliac crest, round the side of the ilium midway between the crest and great trochanter, to the front of the thigh

a couple of inches below Poupart's ligament, and almost parallel with it to the inner surface of the thigh. The lower border is not so clearly defined. It leaves the vertebral column at the level of the upper part of the sacrum, passes round over the ilium, and on the front of the thigh it is more irregular, sending scattered patches as low as the lower third of the thigh. The eruption distinctly crosses the middle line behind for at least the distance of one inch (fig. 3).

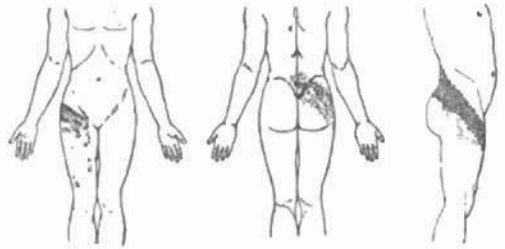


FIG. 3.

Here we have an eruption pursuing a fairly defined course, the upper limits of which slant in almost a straight line from the vertebral column to the inner surface of the thigh. Even if one assumes that part of the 12th dorsal root is involved in this case, it is surely too much to expect that the disease has picked out the portions of the roots affected, whose cutaneous distribution exactly fills up the gaps formed by the irregular outline of the 1st lumbar. Here again, there is undoubted crossing of the eruption to the left of the middle line, a further proof of the overlapping of the nerves.

From the study of cases of herpes zoster, and of the hyperæsthetic areas associated with visceral disease, I have come to the conclusion that there is distinct overlapping of the fields of cutaneous supply of individual nerve roots, of pathic, thermic, and trophic fibres, as well as of those of ordinary sensation. In this respect the results are in harmony with those arrived at by Sherrington from observation of isolated areas producing reflex contraction, with those obtained by Paterson from dissection of fibres from individual nerve roots, and with the observations of Langley on the pilomotor nerves.

VI.—Other Reflex Phenomena in Visceral Disease.

Besides the symptoms elicited from stimulation of the sensory nerve roots, a great number of other phenomena may arise from the stimulation affecting roots of nerves with different functions. If we consider that a stimulation arises in an organ and is transmitted by afferent nerves to a more central situation, and if this stimulation be of sufficient force or of the proper quality to affect certain nerve roots with which it comes in contact, then, according to the function of the nerve root, there will arise phenomena peculiar to the organ stimulated. Thus, if it be a sensory nerve root, there will be an exaltation of its function, giving rise to exaggeration of its peculiar property, or, it may be, causing a lowering of its functional activity, as when anæsthesia occurs. If the nerve root so stimulated be motor in function, then there may arise spasmodic contraction, or even loss of power in definite muscle groups, slowing of the beat or palpitation in the case of the heart. If the nerve root be secretory in function, there may arise an increased activity of the gland whose root is stimulated. In one remarkable case of angina pectoris I had under observation, the attack used to radiate characteristically from the chest to the left arm, and up into the neck. At the same time there used to be a striking and excessive discharge of saliva from the left side of the mouth. In another case of angina pectoris with aortic aneurism, where the pain was wont to radiate down the inside of the left arm, in this area, after a series of attacks, there was gradually developed a streak of ecchymosis, six inches in length. No cause could be assigned for its appearance, and I assumed it to be an affection of the trophic fibres. Hilton refers to certain trophic changes in the skin from disease of the teeth, and I have seen a case of ulceration of the abdominal skin after an attack of gall-stone colic, but as mustard had been used locally, I could not satisfy myself that it might not have something to do with the ulceration. Did we comprehend fully the manner in which this stimulation arising in a diseased organ spreads, we might be able more clearly to understand the meaning of many obscure cases of perverted functional activity of the various organs in the body.

VII.—Effects of Stimulation of the Skin upon the Viscera.

A certain amount of light is thrown upon the subject of the relationship between the cutaneous and the visceral innervation by the study of the effects of stimulation of the skin upon the viscera. The subject from this aspect is akin to that of the cutaneous reflexes, and doubtless lies at the foundation of the effects of treatment by counter-irritation, &c. There are certain well-known effects produced in the viscera by stimulation of the skin, and these are frequently taken advantage of in practice, *e.g.*, the counter-irritation in the pit of the stomach to allay vomiting, and the application of cold to the abdomen to cause firm uterine contraction. A very interesting light is occasionally shed upon this subject by the results of operations, as in the fact that after operations involving the skin of the perineum (for hæmorrhoids and for repair of torn perineum), not unfrequently retention of urine follows. Hilton had noticed that soothing applications to the perineum were beneficial in certain forms of retention of urine. Berry Hart[1] has recently noted a very striking instance of this relation between perineal skin and the muscles involved in the urinary reflex. Remarking the frequency with which retention of urine followed operations on the perineum, he determined to avoid the skin in his sutures. In a series of cases in which this plan was carried out the result was eminently satisfactory, as retention of urine no longer occurred.

The interest from the point of view with which I am dealing here is, that evidently the sacral nerves supplying the perineum are in association with the muscles of the bladder, and not of the mucous membrane alone as Head inclines to suggest.

VIII.—Practical value of recognising the Sensory Symptoms produced by Visceral Disease.

Treating the subject in this somewhat desultory fashion, it is difficult to convey properly the help that is afforded by enquiring carefully into these sensory symptoms in one's every

[1] Hart, D. B., "Perineal suture in relation to retention of urine after labour," *Edinburgh Hospital Reports*, vol. i., p. 587.

day work. I might be permitted to single out a few instances for the purpose of illustrating the value of those symptoms.

I have elsewhere called attention to the particular value of the seat of pain in intestinal obstruction. I do not see a sufficient number of cases to enable me to speak dogmatically on the subject, but in those I have observed, the results have been as striking as they were instructive. The pain in any given case of obstruction is due to the peristalsis of the bowel above the part obstructed. If, then, the pain is situated about the umbilicus, radiating more or less to one side, never descending lower, then one can infer that the point of obstruction is above the great intestine. If, however, the pain be felt as low as midway between the umbilicus and symphysis pubis, then some portion of the great gut is above the point of obstruction. In the latter cases the pain may arise in the umbilical (or even epigastric area) and gradually descend. It is necessary to see the patient when the painful peristalsis is upon him and to enquire carefully of him during the pain, as otherwise the information is too vague to be of service.

The observations that these hints are based upon, are from a dozen cases of hernia of the small intestines, and half-a-dozen cases of obstruction in some portion of the great intestine. The diagnosis was verified either by operation or *post-mortem* examination. These are certainly far too few observations to base an absolute statement upon, but they are of value as suggesting a help in the elucidation of a notoriously difficult point of diagnosis.

The sensory phenomena due to visceral disease may mislead very skilled observers. During my earlier observations on this subject I was called in consultation to see a man in failing health, in whom there was great pain round the left half of the body. There were remarkably few symptoms, besides the pain, and I found a hyperæsthetic area extending from the epigastrium round the left half of the body to the 6th and 7th dorsal vertebræ, which were extremely tender to pressure. I was puzzled with the case, and could only suggest that there was something wrong with the stomach. The patient receiving no benefit from my suggestions, consulted a skilled and deservedly eminent neurologist,

who, on the strength of the tender vertebræ and hyperæsthesia, diagnosed disease of the vertebræ, and recommended the encasing of the patient in a plaster of Paris jacket. This was done, with no relief. In course of time the patient died, and his medical attendant wrote me saying that he had had a *post-mortem* examination, and there was cancerous disease of the posterior wall of the stomach at the cardiac end, and the vertebral column appeared perfectly sound.

The following case illustrates how misleading the sensory phenomena may be in another way. I was called, in consultation, to see a young lady whom her medical attendant informed me was suffering from peritonitis. A year previous, while at a fashionable health resort, she was laid up for four months with peritonitis. The appearance of the patient was typical of that disease, the drawn face, the small quick pulse, and the flexed knees and high temperature. She shrank whenever we ventured to touch the abdomen. Accepting the case as one of peritonitis, in seeking a cause, I proceeded to palpate the region of the vermiform appendix. But the patient would not let me touch the skin, it was so painful. Testing with a pin-head, I found the skin in this region acutely hyperæsthetic, and I was able to map out an area roughly corresponding to the distribution of the 11th and 12th dorsal nerves on the right side. On careful exploration I found that the other regions of the abdomen were not really tender, her desire to protect herself from pain making her frightened of being touched anywhere. On enquiry into the state of the urine, I was informed it was all right, but on examination there was a small quantity of pus. On careful cross-questioning, a distinct history of severe spasms, prior to the last illness, was elicited. I therefore gave the provisional diagnosis of pyelitis. In a couple of days there was an abundant discharge of pus in the urine, the hyperæsthesia disappeared, the temperature fell, and the patient made a quick recovery from her anxious condition.

IX.—The Sensibility of the Subcutaneous Tissues.

A knowledge of the sensibility of the subcutaneous tissues of the external body wall would be of great value. Are the pains of tissues lying under the skin referred or local? It seems almost absurd to ask the question, yet there are a number of very curious facts elicited when the subject is enquired into—as the well-known pain at the knee from in-

flammation of the hip-joint, and the hyperæsthesia of the skin associated with joint disease. That the subcutaneous tissues can become acutely sensitive, has already been illustrated, and the occurrence of afferent nerve fibres in muscles has recently been put beyond doubt by the investigations of Sherrington. But when one comes to examine the matter it is very difficult to obtain satisfactory results. I have been in the habit for a long time of performing operations (after rendering the skin anæsthetic) without eliciting the slightest symptom of pain. Lately a number of hernias has been operated upon in the Victoria Hospital without an anæsthetic, and after the skin was cut no pain whatever was elicited. The last one, however, on which I operated, did not yield such conclusive results. In this case, when dissecting the tissues overlying the hernia, the patient occasionally called out. On testing the portion of tissue, the cutting of which had caused pain, I never could reproduce the sensation. After the hernia was reduced, I brought the deep parts together by a series of catgut sutures, until all the tissues, save the skin, were approximated. In such cases I do not suture the skin, but hold the edges together, and paint the line of incision with celloidin solution. This dries quickly and brings the skin edges firmly together. In this manner the whole of the tissues, from peritoneum to subcutaneous fat were systematically stitched, and there was not the slightest pain evoked.

In many ways the knowledge that subcutaneous tissues are practically insensitive to stitching is of great practical value. Thus in recent ruptures of the perineum, the torn surfaces can be brought at once accurately together, with practically no suffering on the part of the patient by avoiding the skin in suturing. When skin sutures are employed, the suffering is frequently so great that the perineum cannot be satisfactorily stitched without an anæsthetic.

These facts were matters of common knowledge in pre-chloroform days, and many surgeons of to-day are no doubt cognisant of them. In conversation with an aged surgeon, who had seen much practice before chloroform was introduced, he informed me that it was always understood that after the skin was cut no pain was suffered during an operation, unless occasionally when a nerve was cut.